POWER

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Writing In

THE EDITOR of the Questions Department has been having interesting correspondence with one of his readers.

Incidentally, it develops that the reader is particularly interested in the questions and the discussions that they evolve and has written and sent in answers to and opinions upon some of them.

And, notwithstanding none of these contributions has ever got into print, he is going to continue to write and send them.

Because, in the first place, it stimulates his interest. The questions raised are out of the ordinary. There is in them material for consideration and discussion.

He finds that they not only challenge his engineering skill and ability but develop his powers of analysis and directness of thinking. They give him a definite problem to work upon.

Writing out a succinct reply to one of these questions is quite different from merely mentally framing a cursory answer.

When you come to actual grips with the question in all of its bearings, and try to put your ideas into words that cannot be misunderstood, it is often the case that it presents more possibilities than were at first apparent and that several considerations must be followed to a conclusion.

And then there is the necessity, after a conclusion has been reached that will stand the application of all the conceivable considerations, of expressing that conclusion intelligibly and convincingly.

The most effective way of perfecting your own knowledge of a subject is to try to teach it to others. Their questions, or your anticipation of them, will open up lines of thought which might otherwise never have occurred to you. Surprising, sometimes, the things one does not know about familiar subjects.

The determination of the correspondent to keep on answering the questions indicates a spirit that will win. The man with a brain movement is on his way. I have seen many a man write himself into the foreground of the picture.

F. R. Low

EDITORIALS

Power-Service Management By Unit Costs

EFFICIENT MANAGEMENT of the power services is hardly possible without unit-cost records. Through their more extensive use in the future power engineers in industry will reduce manufacturing costs and increase their own prestige and earnings.

To look upon such records as mere bookkeeping entries is to miss their true significance. Their function is dynamic; they must serve as detectors of waste, as criteria of personal efficiency, and as levers to force remedial action.

Is the coal bill high in the heating plant? The unit steam cost will show whether the difficulty lies with the boiler plant or with the factory. If with the factory, studies relating steam consumption to product output will show whether waste or legitimate increase in demand is the cause.

Unit power-cost records, properly constructed, will make it possible to bill each department on the basis of metered consumption. Such charges, experience conclusively proves, establish a sound basis for fixing the cost of factory product and result immediately in a lowering of that cost by reducing departmental waste. It is a human tendency — particularly in America — to waste that which is not charged for on the basis of actual consumption.

An incidental benefit of unit cost-keeping is that it stamps the engineer as an executive and a business man, entitled to far greater responsibilities and a higher reward.

What unit costs should be recorded? Steam and electricity should always be reduced to a unit basis. Where refrigeration, hot water, compressed air, pumping or other services involve substantial consumption and the possibility of wasteful use, their individual unit costs should be determined and used in charging departments for actual consumption.

Finally, any plant producing a staple product should record the total power-service cost per unit of factory output; barrel of flour, thousand feet of lumber, barrel of oil refined, etc. In some cases it will pay to break this down into its elements. Such subdivided unit costs uncover profit leaks for executive attention.

Since unit-cost records are so vitally related to the effectiveness and personal success of the power engineer, he should lead, not follow, in putting such systems into effect.

Preventive Maintenance

EVERYONE familiar with plant-operating problems agrees that preventive maintenance is economically sound. It is usually less expensive to locate and correct a fault before a breakdown than after a service interruption occurs. An unexpected equipment failure may cause serious damage and long delays in restoring operation. Loss of production due to such interruptions may be several times as expensive as equipment repairs. Preventive maintenance, in addition to assuring service continuity and reducing operating costs, reduces working hazards.

Just how these benefits are to be obtained is not generally understood, because of their many ramifications, some of them involving plant design, equipment selection and installation. How the plant is laid out and how the equipment is selected, installed and protected all have a bearing on the maintenance program. Unless the equipment is suited to the application, it will be difficult to make it give service. On the other hand, no matter how well adapted machines may be to the job, unless they are properly protected against overload and other hazardous conditions, unexpected and costly breakdowns are likely to happen. Many large electrical machines have been wrecked because a reverse-current relay of almost negligible cost was not provided.

To know what is going on inside a machine is just as important as taking care of the outside. For this reason meters have a primary place in preventive maintenance. A change in a motor's power consumption may lead to the detection of a fault that would but for the meter reading be undiscovered until serious damage was done, and allow for its repair at small cost. On large machines ventilating-duct conditions have a marked

influence on the temperature of the winding and the life of the insulation. In the maintenance of these machines, means for recording winding temperatures give valuable information as to their internal conditions. Insulation is an uncertain quantity in the operation of every electrical machine, and may remain in a dangerous condition too long unless periodic meter readings are taken of its resistance and records kept.

Keeping machines clean, properly lubricated and adjusted and the keeping of records have an important place in preventive maintenance. But more must be known about equipment than surfaces indicate before a real job can be done. Many machines have failed from internal causes which gave no external indications of the pending trouble. Most of these weak spots can be found in their early stages by a proper system of load, temperature and insulation-resistance records of the equipment.

Power Producers Pioneer for Clean Air

IN THESE DAYS of increasing public interest in the abatement of smoke, sulphur, fly ash and the numerous other forms of air pollution, it is the plain duty of engineers firmly to guide their less-informed brethren through the maze of disconnected ideas at present prevailing.

There is not the slightest doubt that the whole subject is very much alive. A tendency is also evident to regard the problem of purifying the air as almost wholly the responsibility of the power producers. Because engineers know this view to be incorrect, they should take pains to see that the laymen also have the facts.

They should be told of the splendid spirit with which the power companies large and small are seeking to do their part; of the large sums they are spending in air-purification research; of the millions of dollars used for the purchase of the best available means for removing objectionable matter from flue gases.

These are only a few of the activities. The problem is far from solved and many unforseen difficulties must be overcome, on the way. As an example, it has been felt that the elaborate washing of flue gases at the Battersea and Fulham plants of London would successfully solve the problems arising from a high sulphur content.

In the removal of the objectionable sulphur from the stack discharge the plan promises to be very efficient, but the consequent cooling of the flue gases now presents a new threat. Scientists are seriously concerned with the danger, under favorable atmospheric conditions and in foggy weather, from the concentrated gases descending and blanketing certain areas. Under some circumstances it is conceivable that this would result in a repetition of the Belgian disaster. The stack gases may have to be reheated to avoid this.

Yet the power producers are going about their air-purification problems with a will and determination that places them in the forefront of active agencies in the clean air crusade.

Now, how about some of the other sources, such as street dust, domestic coal users, chemical plants, and that arch offender in all centers of population, the ubiquitous taxicab?

School Ventilation

NEW YORK is one of the states having laws which provide minimum requirements for school ventilation. Most of these laws specify that there shall be supplied at least thirty cubic feet of fresh air per minute for each pupil, and that vitiated air shall be removed by positive means. This amount of fresh air is sufficient to maintain a CO_2 concentration not exceeding seven parts in ten thousand, above which ventilation is easily felt. A concentration of ten parts of CO_2 in ten thousand may cause actual discomfort.

A bill is now before the New York Legislature which proposes to modify the present law by removing all specific minimum requirements as to fresh air supply and removal of vitiated air. As amended, the law will state that the Commissioner of Education shall not approve school building plans unless they provide for proper ventilation. This would leave the decision as to what is and what is not proper ventilation entirely in the hands of men who are not engineers but political appointees. If the amendment is passed the law will be ineffective for securing the kind of ventilation needed in schools. It would permit reversion to the open-window method of ventilation of fifty years ago.

The present law needs revision to bring it in line with latest practice, but this is no excuse for removing all restriction. The American Society of Heating and Ventilating Engineers is now preparing a ventilation code part of which will refer to the ventilation of schools. It will be wise for the Legislature to defer action until it has had opportunity to study this code and the recommendations of the experts who have compiled it.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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New Mill Drive at Smith Paper Co. Aids Heat Balance

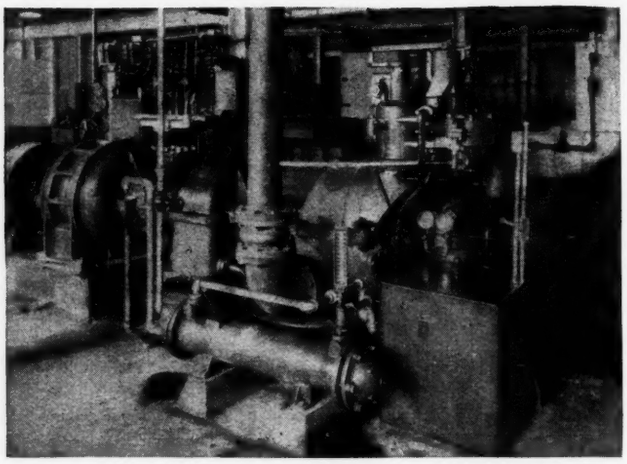

Fig. 1—Geared-turbine motor-generator comprising 175-hp. turbine, 100-hp. synchronous motor and 40-kw. d.-c. generator

A synchronous motor on the turbine shaft permits the unit to be governed by low-pressure steam demand, the surplus or deficiency of power being taken by the utility system

By ROLAND A. PACKARD
Plant Engineer
Smith Paper Company

THE average paper mill has been slow to modernize mechanically and take full advantage of the economies made possible through steam and electricity. The paper machine was much the same in design and mode of drive up to a decade ago. Competition has been a prime factor in refinements of construction, increase of size and speed as well as the application of equipment to give electric and steam power economies.

The amount of process steam used by a paper machine depends on the size, speed and weight of the sheet made. This steam requirement may vary considerably from day to day or from week to week as different kinds of paper are produced. Where several machines are operated in the same mill a common low-pressure main may be used to convey surplus steam from the prime mover on one machine to another where the heating demand may be large. The mill heating requirement in winter places a seasonal demand on the low-pressure steam system. These fluctuating requirements have made it imperative to develop methods for maintaining a steam balance under all conditions, no matter when and how they may arise. Without the use of electric power much of the present economies would not be possible.

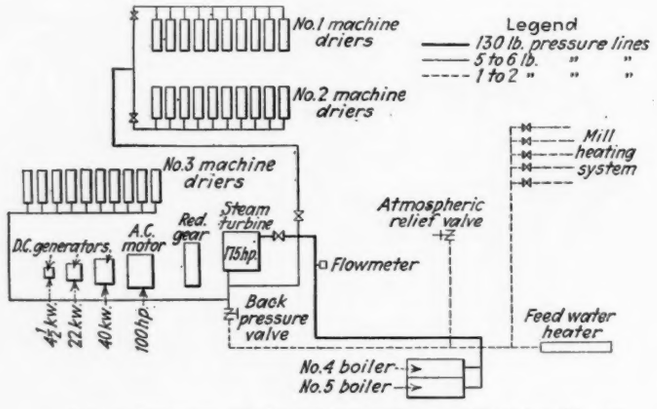

Fig. 2—Diagram of steam distribution at the Columbia mill

The last addition to the Smith Paper mills in Lee, Mass., was at the Columbia mill, making a total of nine machines. This mill is a two-machine unit, and with the addition of a third machine there was offered an excellent opportunity for maximum economy in the use of equipment for steam balance and precision of mechanical and electrical control.

Careful analyses were made of prime movers and machine drives. The following combinations were considered:

1. Constant-speed steam turbine connected through reducing gears to the constant-speed line, with a direct-current generator to supply power for a variable-speed motor on the variable-speed line.
2. Constant-speed steam turbine direct connected to a synchronous motor, and direct-current generators to provide for variable-speed drive.
3. Constant-speed steam engine, with direct-current generator supplying power to constant- and variable-speed motors.
4. Constant-speed steam turbine direct connected to an alternating-current generator employing General Electric BTA motors for variable-speed requirements.
5. Constant-speed steam engine employing variable-speed hydraulic transmission.

Plan 2 best fulfilled the requirements of dependability, ease of supervision, constant-speed

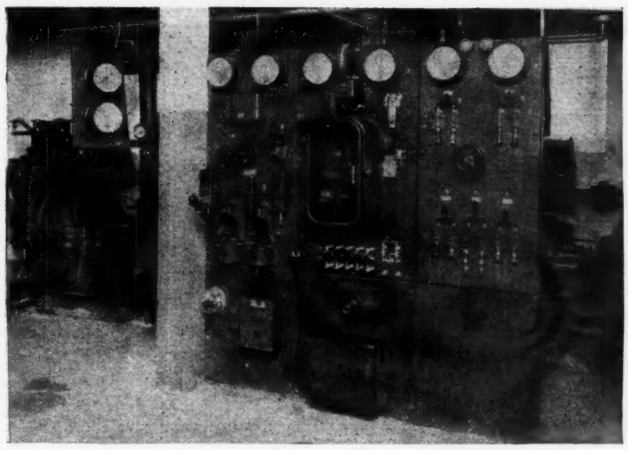

Fig. 3—Synchronous motor control, speed regulator and d.-c. feeder panels for paper machine drive

regulation, economy in operation, freedom from interruption of power, and maintenance of mill steam balance.

The paper machine was laid out with the constant- and variable-speed shafts in the basement. The steam-turbine set was placed directly under the dryers. The several small variable-speed motors were located on the floor with the machine except for the one on the stuff pump, which was also placed in the basement.

Fig. 2 shows the high- and low-pressure steam connections. The steam turbine shown in Fig. 1 is equipped with throttle- and back-pressure solenoid-operated controls. Normally, the back pressure control functions to maintain between five and six pounds pressure. An increased demand for process steam will deliver more mechanical power to the generators. Since the power demand on No. 3 machine may remain the same, the surplus power may be pumped back to the power system. Conversely, in the summer, with no mill heating requirement the low-pressure steam demand may be minimum, resulting in less power being generated by steam than is required to operate No. 3 machine. Then power must be taken from the utility system to make up for this deficiency.

Through any and all of these changes the speed of the paper on the machine is maintained practically constant by means of a special solenoid-operated commutator between the segments of which are resistance units which operate a Ward Leonard control system between the 40-kw. direct-current generator and the variable-speed motor. A small pilot generator, shown in Fig. 5, has a constant and separately excited field, and, in turn, registers a change in armature voltage for any slight change in speed of the variable-speed line, to which it is connected by a silent chain. This change in voltage effects a solenoid to which it is connected in the speed regulator, shown in the middle of the center panel in Fig. 3. Through a mechanical hook-up it changes the resistance, and, consequently, the voltage, on the field of the 40-kw generator. The differential action is very small, enabling the operator to maintain a red line on the recording tachometer which appears to have been drawn with straight edge and pen.

Fig. 4 shows the main electrical connections. The synchronous motor is connected to the public utility's 2,200-volt, 3-phase lines protected by overload relays. This motor operates as a generator whenever the exhaust steam demand is greater than the electrical power requirements for the operation of the paper machine.

Switch *A*, Fig. 4, represents the main line switch from the public utility. Switch *B* is an auxiliary switch that is tripped weekly to simulate as closely as possible the loss of public utility power on the turbine system. The connection to the finishing room allows for a supply of power from the steam turbine-generator whenever the steam requirement is greater than the electric load on No. 3 machine. Switch *C* is the main line switch at the Columbia mill substation and has a capacity of 3,000 kva. at 2,200 volts. Any surplus power generated by the turbine set automatically supplies part of the mill load in the finishing room.

The variable-speed shaft is equipped with a magnetic clutch between the wet and dry ends of the machine. The dryers as one group and the calender are also equipped with these clutches. All of them have push-button control on the front of the machine.

A feature of the 175-hp. turbine is the automatic transfer of any power from the outside source to the turbine whenever this source fails. In the summer this is apt to happen as a result of lightning disturbances. A relay opens the main switch as well as transfers the turbine from back-pressure to throttle control, all without breaking the paper on the machine or changing its

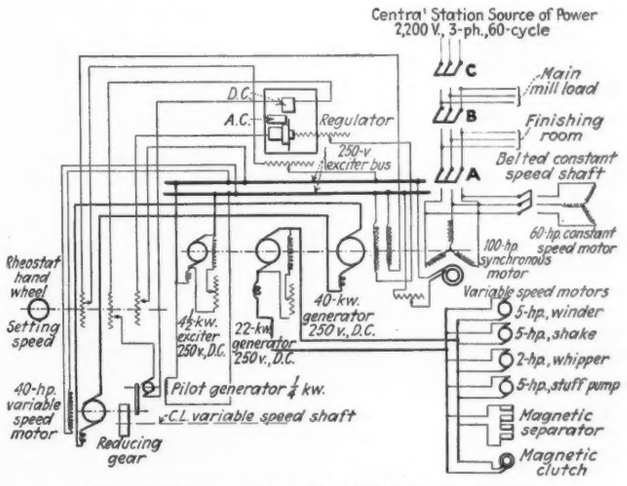

Fig. 4—Diagram of main electrical connections

speed. When the outside power is restored it may be synchronized with the alternating-current motor and turbine operation transferred to back-pressure control through manual replacement of the two solenoid cores.

This machine was designed and built by Rice Barton & Fales especially for the manufacture of high-grade tissue papers. The design incorporated a speed range of 75 to 250 ft. per minute. To accomplish this change a manually operated system of rheostats was installed at the dry end of the machine. Above the wheel handle, but chained to it, is a pointer that may be set at any desired speed whether or not the machine is in operation. If the machine is in operation the speed change takes place at a gradual rate, independent of the handwheel movement, until the desired and indicated speed has been reached. In this manner no undue mechanical strains are placed on transmission equipment. On the same panel there are start and stop push buttons. Likewise, when the machine is stationary some ten to twenty seconds elapse after pushing the starting button before the machine has attained a desired speed.

Further reference to Fig. 2 will show the interconnected steam lines. Before the installation of No. 3 machine, machine Nos. 1 and 2 were operated by steam engines, the exhaust from which dried the paper and supplied steam for the heating system. Since only a fraction of the total exhaust steam from either engine was used in drying the tissue paper, large quantities of steam were wasted to the atmosphere in the summer. These engines have been replaced by constant-speed electric motors operated directly from the public utility's system. Any interruption of power, of course, shuts them down, with the consequent delay of a half hour to wash up the wire and felts and get started again. Eventually these two machines can be made to operate in their present mechanical and electrical transmission arrangement without stopping in the event of central-station power interruption.

The equipment has been found dependable. It has substituted push-button or manually operated switch control for separate motors in place of heavy levers and mechanical transmission connections. This combination has afforded an improved system for the various variable speed requirements which should lessen the maintenance cost of the equipment over a period of years. Constant-speed regulation, combined with no interruption from power sources, are vital factors in a low production cost and constant-weight paper. The perfection of mill steam balance in connection with all three machines has shown the largest element of economy.

The power system for the five mills on the Housatonic River involves a 20,000-volt transmission line, with a transformer station at four of the five mills. The distance between the first and fifth mill is about four miles. In the center of this distance a hydro-electric plant, operating under a 25 ft. head, pumps power into the high line, as it is called. The high line, of course, is owned by the public utility and is arranged so that it may be fed from either end, thereby reducing the possibility of power interruption in the mills. The total connected motor load runs about 5,700 horsepower.

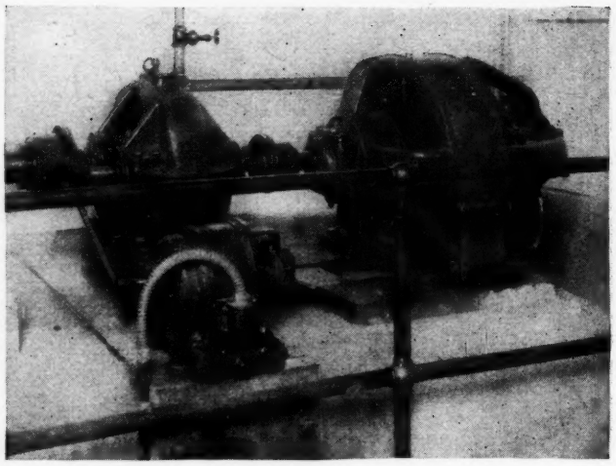

Fig. 5—Variable-speed, 40-hp., d.c. motor geared to back line shaft, and chain driven pilot generator

Occasionally, when the mills are not running (for example, on Sundays and holidays), there is available a surplus of hydro-electric power. The power generated and delivered into the high line would naturally be supplied back into the western Massachusetts system. No credit is received for such power; therefore, an attempt is made to store surplus water for week-day use.

The equipment was designed by Messrs. James M. Wade and E. L. Richardson, of the General Electric Company, and installed by the Smith Paper Company.

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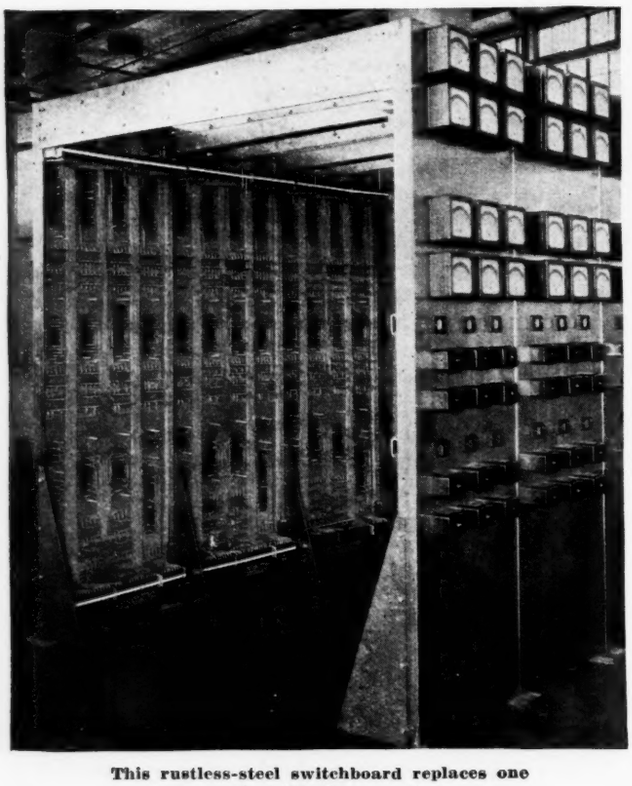


This rustless-steel switchboard replaces one made with slate panels

Switchboard Panels Made of Rustless Steel

A LARGE power-plant switchboard of stretcher-leveled rustless steel is being installed by Henry Ford at his River Rouge plant, replacing in a more compact form an old slate switchboard that could no longer be made to accommodate additional equipment. Here a construction of stretcher-leveled steel panels offered an advantage in compactness. By making the panels of bright steel, with a dull polished satin finish, lacquer or paint finish was superfluous.

The illustration shows the front board for the instrument equipment and the rear board for meters and relays. The two boards are installed back to back in a semi-circle around the independent control bench, which is likewise executed in rustless steel, by the General Electric Company. The instrument and relay boards are interconnected. Structural braces, also of rustless steel, serve the secondary purpose of runways for the electrical interconnections.

Champion Forge Installs

Coal Silo and Big Boiler

1

Reinforced concrete silo, 67 ft. high, 27 ft. inside diameter, 6 in. thick, 950 tons' capacity.

2

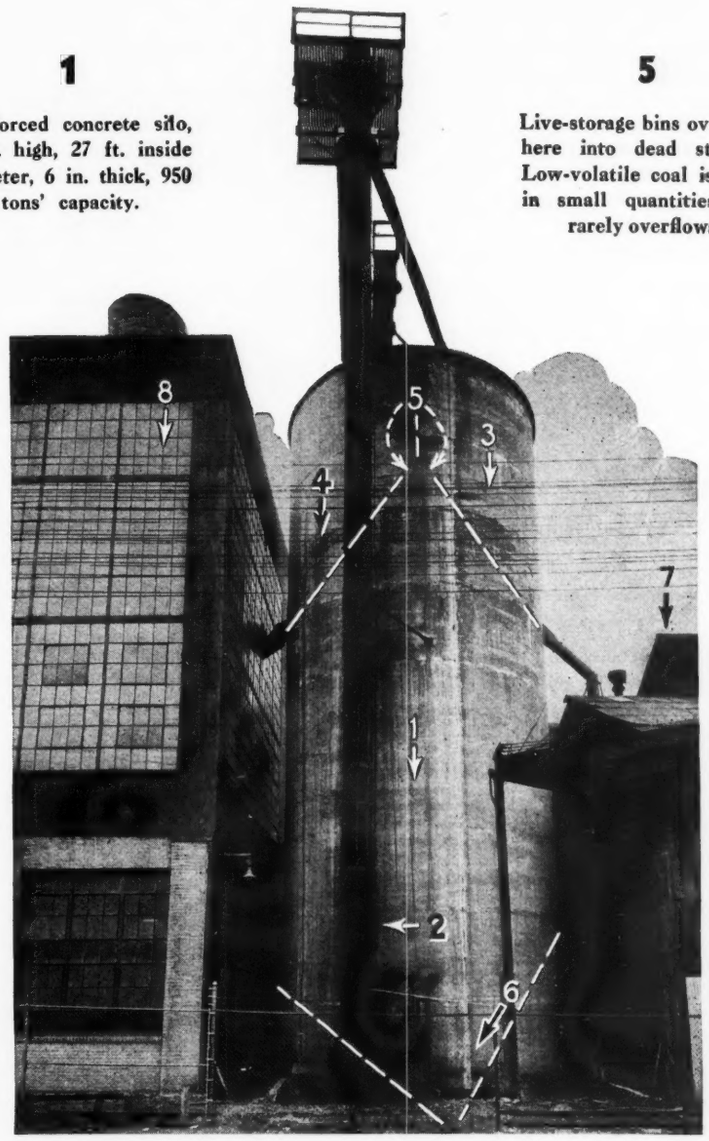
Fuel from track hopper, to reciprocating feeder, to crusher, and then up through this bucket elevator—35 tons per hour.

3

Low-volatile coal fed to this pocket (live storage) discharges to old boiler room on the right.

4

High-volatile coal (live storage) discharges to new boiler room on the left.



5

Live-storage bins overflow here into dead storage. Low-volatile coal is used in small quantities and rarely overflows.

6

Coal from bottom of dead storage may be discharged to reciprocating feeder and elevator for return to live storage.

7

Old boiler house, with low-set boilers, requires low-volatile West Virginia coal to comply with the Cleveland smoke law.

8

New boiler house, modern, high-set and stoker-fired, burns high-volatile Pittsburgh No. 8 coal (1¼ in. nut and slack) smokelessly.

DESCRIBED as a unique installation for a forge plat, a 950-ton-capacity coal silo, a 10,000-sq.ft. water-tube boiler, stoker-fired, economizer and other auxiliary equipment have been installed at the plant of the Champion Machine & Forging Company at Cleveland.

The concrete silo stores two varieties of coal, low-volatile and high, for old and new boiler plants, respectively. Compared with overhead coal bunker, advantages claimed for silo by Champion are: lower cost of erection, cheaper operation, less space, greater storage capacity.

Equipment includes 10,000-sq.ft. Connelly water-tube boiler for 300 per cent continuous operation; 10-retort, 25-tuyère Taylor stoker; water-cooled bridge wall; air-cooled front and side walls; Hall system of feed treatment; Hagan combustion control; Bailey boiler meters; Foster-Wheeler economizer and Allen-Sherman-Hoff ash hopper.

The boiler house was designed by W. C. Kammerer, M.E., of Hadlow, Hughes, Hick & Conrad, engineers and architects of Cleveland. Stephens-Adamson Manufacturing Company was the coal-handling equipment contractor.

According to J. Fred Connelly, vice-president of Champion Machine & Forging Company, the new unit will save 100 tons of coal per week. There will be an additional saving from the ability of the new high-set boiler to use low-cost high-volatile coal with practically no smoke.

AUTO-TRANSFORMERS
for Starting Induction Motors

Although induction motors designed for starting on full voltage have come into general use, there are a vast number in service that are started on reduced voltage. The voltage is supplied by auto-transformers. How to select and care for this equipment so as to obtain good service is told in this article

By ANDREW HOLT
Irvington, Calif.

MANY squirrel-cage induction motors are started on low voltage by devices variously known as starting compensators, auto-starters, or induction starters. Usually an auto-transformer is employed to reduce the line voltage to a suitable value for starting. The principal reason for applying low voltage is to reduce or eliminate the drop in line voltage that would result if a squirrel-cage motor of ordinary design was started across the line. A secondary reason is, the shock to the motor or the driven load, or the belt slippage, due to starting on full voltage, cannot be permitted. Since the starting torque of an induction motor varies as the square of the voltage (Table I), a reduction in starting torque, and shock, will result by applying low voltage.

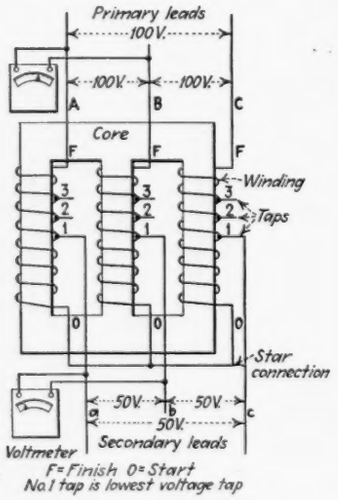


Fig. 1—Voltmeters connected to test 3-phase auto-transformer

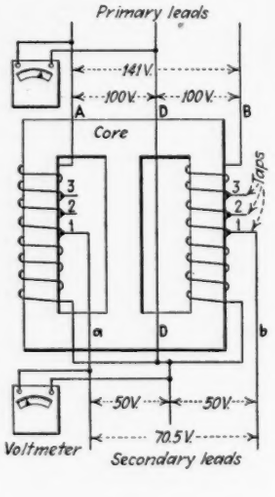


Fig. 2—Voltmeters connected to test 2-phase auto-transformer

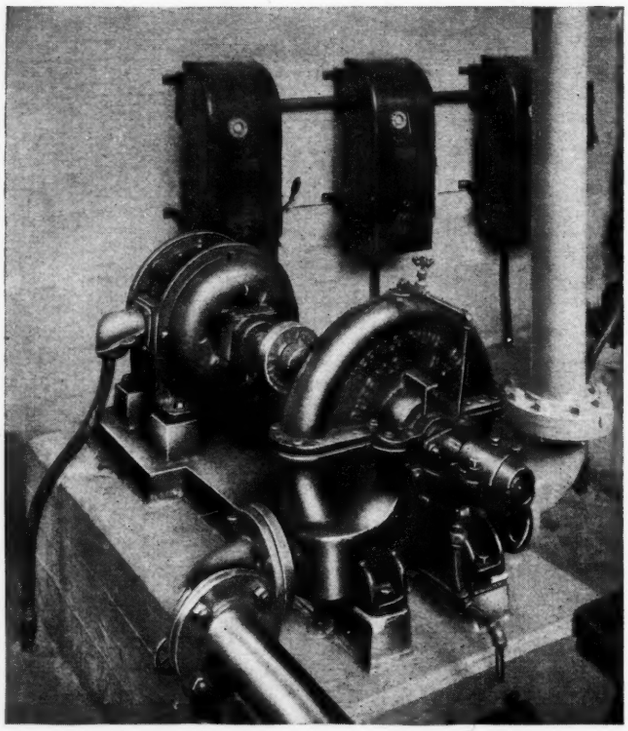


Fig. 3—Auto-transformers start squirrel-cage motors driving transformer oil pumps

If rated voltage is applied to an ordinary induction motor its starting torque may be 150 to 300 per cent of the torque developed at full-load speed, depending on the motor's design. The values given in Table I are based on a starting current, at rated voltage, of 700 per cent of full-load value. Under these conditions the starting torque is 200 per cent of the full-load running torque.

Induction motors of ordinary design up to 10 hp. are generally started on full voltage. With the introduction of the high-reactance induction motor, across-the-line starting is becoming common for all sizes where conditions are favorable. Motors of this type are usually slightly lower in both power factor and efficiency than those of low reactance.

Motor-starting auto-transformers are always of the

TABLE I—SQUIRREL-CAGE INDUCTION-MOTOR VOLTAGES, CURRENTS AND TORQUES

Per Cent of Rated Voltage Applied to Motor	Per Cent Full-Load Current in Line	Per Cent Across-the-Line Starting Current	Per Cent Full-Load Current in Motor	Per Cent Full-Load Running Torque
40	112	16	280	32
50	175	25	350	50
60	252	36	420	72
70	343	49	490	98
80	448	64	560	128
90	567	81	630	162
100	700	100	700	200

polyphase type, Figs. 1 and 2, which permits a saving of core material and space as compared with single-phase units of combined capacity. Modern auto-transformers of this type are designed to start the motor at 4-min. intervals for one hour, allowing 15 sec. per start. Older auto-transformers were designed to start the motor at half-hourly or hourly intervals, allowing 30 or 60 sec. per start. The copper and iron are worked at high densities to obtain the advantages of these intermittent ratings. It is obvious that the magnetizing current and efficiency are not of prime importance, since auto-transformers of this type are in circuit but little of the total time.

Their exciting current is high. On 60-cycle auto-transformers the exciting current should not exceed 25 per cent, and on 40 and 25 cycles, 30 per cent, of the motor's full-load current. Rated voltage and frequency should be maintained while testing. Due to this heavy exciting current, and to the high core loss, auto-transformers of this type are likely to overheat if energized for a few minutes, even though current is not taken from the taps. Auto-transformers having higher exciting currents than those given above may be found in use.

To meet varying conditions, auto-transformers for starting duty are provided with two or more full-capacity taps, as shown in Figs. 1 and 2. These taps are rated according to the voltage that exists between those of the same number, expressed as a percentage of the line voltage. Standard auto-transformers up to 50 hp. are now provided with 65 and 80 per cent taps, and with 50, 65 and 80 per cent taps in larger capacities. Many auto-transformers are in service having 40, 58, 70 and 85 per cent taps. Usually only the lowest and highest tap voltages appear on the nameplate.

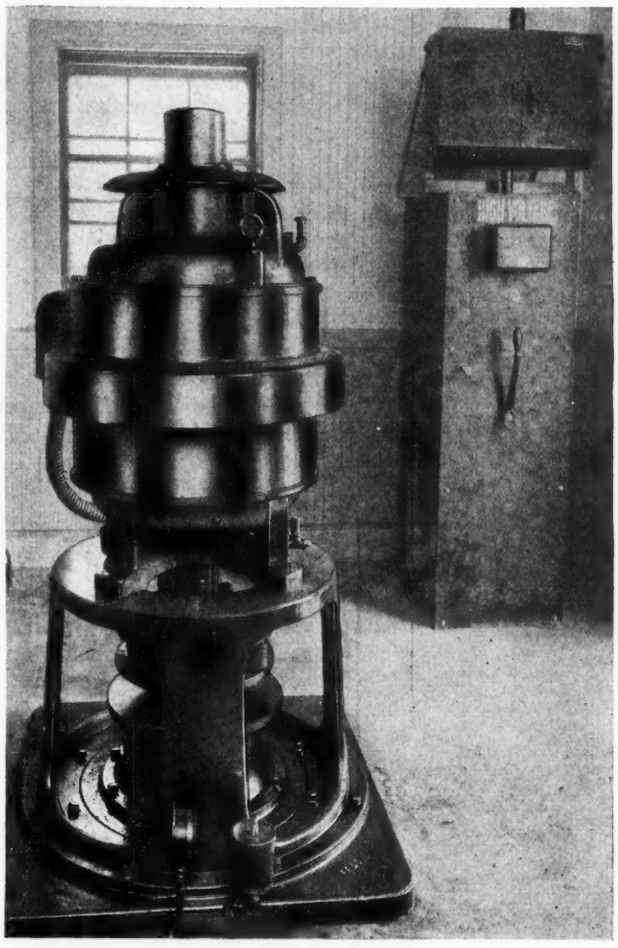


Fig. 4—Auto-transformer starts 2,200-volt motor driving deep-well pump

If the tap voltages are not known they may be found by testing with a voltmeter, as shown in Figs. 1 and 2. If the line potential exceeds 750 volts a voltage transformer must be interposed between the voltmeter and the auto-transformer's leads. It is not necessary that rated line voltage be applied to the primary winding; any voltage high enough to give readable voltmeter deflections will be satisfactory. In Figs. 1 and 2 the applied voltage is 100 volts, and the high and low voltages are read on separate voltmeters. Generally the applied voltage is so steady that one voltmeter will suffice, it being transferred from one circuit to another. The voltage between taps of the same number on three-coil auto-transformers may be slightly unbalanced due to magnetic leakage resulting from the high magnetic densities.

Open-Delta Connection

As shown in Fig. 2, two-phase auto-transformers are generally tested connected open delta. Voltage *AD* is checked against voltage *aD* and voltage *BD* against *bD*. Metal tags are usually attached to the auto-transformer's coils. If the data stamped thereon are sent to the manufacturer, information as to voltage and rating can usually be obtained. Many three-phase auto-transformers are provided with two instead of three coils. These are tested and operated open-delta connected.

Because of the voltage and current phase relations that result when the open-delta connection is used on a three-phase circuit, the combined capacity of the two auto-transformers required for this connection must be 15 per cent greater than the combined capacity of the three auto-transformers required for the star connection. Further, the open-delta connection causes the line currents to be at least 15 per cent greater in one conductor than in the other two while the motor is connected to the auto-transformer for starting. This unbalance should be considered when planning power circuits.

Auto-transformers perform well in service, especially when it is considered that they are generally operated by unskilled persons. Such failures as occur are usually due to overloading caused by using an auto-transformer that is too small, by leaving the motor connected to the taps, by leaving the auto-transformer connected to the line, and by starting duty that is unusually severe. A burned-out auto-transformer can usually be determined by inspection of the windings, but sometimes testing is necessary. The exciting current of a damaged auto-transformer will probably be high and unbalanced, and arcing, burning or smoking will usually result shortly after voltage is applied. Further, the tap voltages may be badly unbalanced. New windings cannot usually be obtained without the core.

When repairs are made care must be taken to see that the conductors are proportioned and connected properly to carry the current that will flow under all normal conditions. If, in Fig. 5, lead *F* instead of lead *O* were connected to lead *N* damage would result because the current in winding from *O* to the 50 per cent tap would be 240 amp., under certain conditions, instead of the maximum permissible current of 150 amp. Auto-transformers are insulated to withstand a dielectric test of twice rated voltage plus 1,000 volts based on the motor's voltage rating. A megohm meter is generally used to check the insulation as part of a systematic maintenance schedule. High-voltage testing should be avoided. In

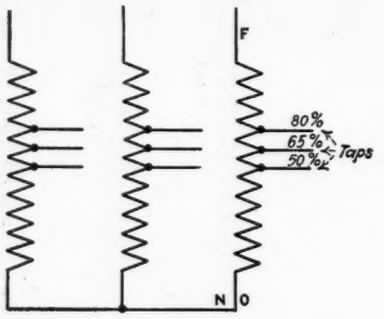


Fig. 5—Diagram of three auto-transformers connected in star

TABLE I—AMPERES, VOLTS, AND KVA. WHEN 300 AMP. IS SUPPLIED FROM AUTO-TRANSFORMERS' TAPS, FIG. 5

Current Delivered From	Amp. in Windings	Line Volts	Tap Volts	Output Kva.
50% tap	O to 50% tap, 150 50% tap to F, 150	440	220	114
65% tap	O to 65% tap, 105 65% tap to F, 195	440	286	148
80% tap	O to 80% tap, 60 80% tap to F, 240	440	352	183

general, motor-starting auto-transformers should be cared for in the same manner as two-winding transformers.

In sizes up to 300 hp., auto-transformers are inclosed in the same case as the switching equipment, thus forming a self-contained induction starter. In larger sizes the auto-transformer and switching equipment are mounted separately. When separately mounted, auto-transformers for line voltages above 2,200 are sometimes oil-immersed. Auto-transformers are listed up to 1,000 hp., but larger sizes can be obtained. However, where large motors are to be started the necessary low voltage is often taken from taps on the main transformers.

The proper taps to employ are those that will bring the motor to full speed promptly, yet without undue mechanical shock or disturbance to voltage. If the motor accelerates too slowly the auto-transformer may be overheated. The remedy is to use higher voltage taps. It is important that all taps be thoroughly insulated.

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Waste-Heat Boilers at Huntington Works

WHEN the International Nickel Company decided to build its refinery at Huntington, W. Va., in connection with the rolling mills, the utilization of waste heat received careful consideration, as it was desired to have, in connection with the electric furnaces, a source of power supply that would, to a certain extent, take care of the peaks. With this in mind and having a number of single Rust boilers from another plant, it was decided to use these boilers in connection with the furnaces. At first it was contemplated to use one setting of the boilers, which comprised four drums, as a water-heating unit and in front of this the second set of boilers, comprising four drums. After a careful check-up of the arrangement it was decided to take three boilers and construct therefrom two six-drum units.

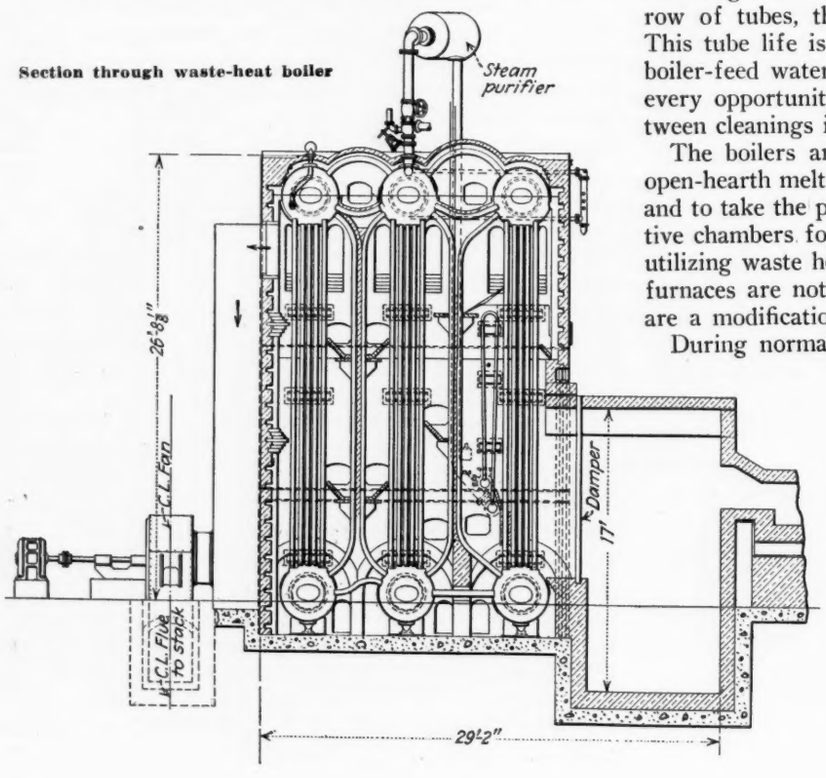
Each boiler is equipped with standard superheater and a 6-in. drum-type steam purifier, and has a nominal rating of 18,000 lb. of steam per hour at 150-lb. pressure and 100 deg. F. superheat. Each has delivered as much as 619,000 lb. of steam in 24 hr. from a feed-water temperature of 100 deg. F.

As the making of steam is secondary to the melting of metal, no refinements were installed for maintaining a high boiler feed temperature, and there are times when it is not possible to economically make use of all the steam. The boilers furnish steam for many uses about the plant and for two 750-kw. steam turbines.

Owing to the extremely high temperatures at the first row of tubes, the tube life is about eighteen months. This tube life is obtained only after proper treating of boiler-feed water and the use of mechanical cleaners at every opportunity. The average run of the boilers between cleanings is 90 days.

The boilers are operated in conjunction with 20-ton open-hearth melting furnaces, one boiler to each furnace, and to take the place of the usual checkerwork regenerative chambers found in the steel industry as a means of utilizing waste heat. It should be understood that these furnaces are not truly the open-hearth type, but rather are a modification of the copper reverberatory furnace.

Section through waste-heat boiler



During normal operation each boiler derives its heat input from the waste heat contained in the furnace flue gases. In order that the boiler operations should not be wholly dependent upon the melting operations or, in other words, to be able to operate the boilers during shutdown periods for furnace repairs, auxiliary burners are provided.

Over-all thermal efficiency of the combination is approximately 56 per cent, which greatly exceeds the efficiency to be obtained by the use of the customary checkerwork regenerative chambers.

Osage River Development Nearing Completion

DESIGNED for an initial capacity of 201,000 hp. in six units and an ultimate eight-unit capacity of 268,000 hp., construction work is progressing rapidly on the $30,000,000 undertaking of the Union Electric Light & Power Company. With the Keokuk plant on the Mississippi River and the Cahokia and Ashley Street steam stations in East St. Louis and St. Louis, it will form the third corner of a great triangular base of dependable power. Initial output will be transmitted at 132,000 volts over three lines to the company's substations at St. Louis, and the Rivermines plant of the St. Joseph Lead Company, where arrangements have been made to supply a block of power amounting to 26,000 kw., or 160,000,000 kw.-hr. per year.

The plant is on the Osage River four miles from Bagnell, Mo., which is near the center of the state and about half way between St. Louis and Kansas City. Physical data on the entire development appear in an accompanying table, and in the line drawing are shown typical sections of the hydraulic structure.

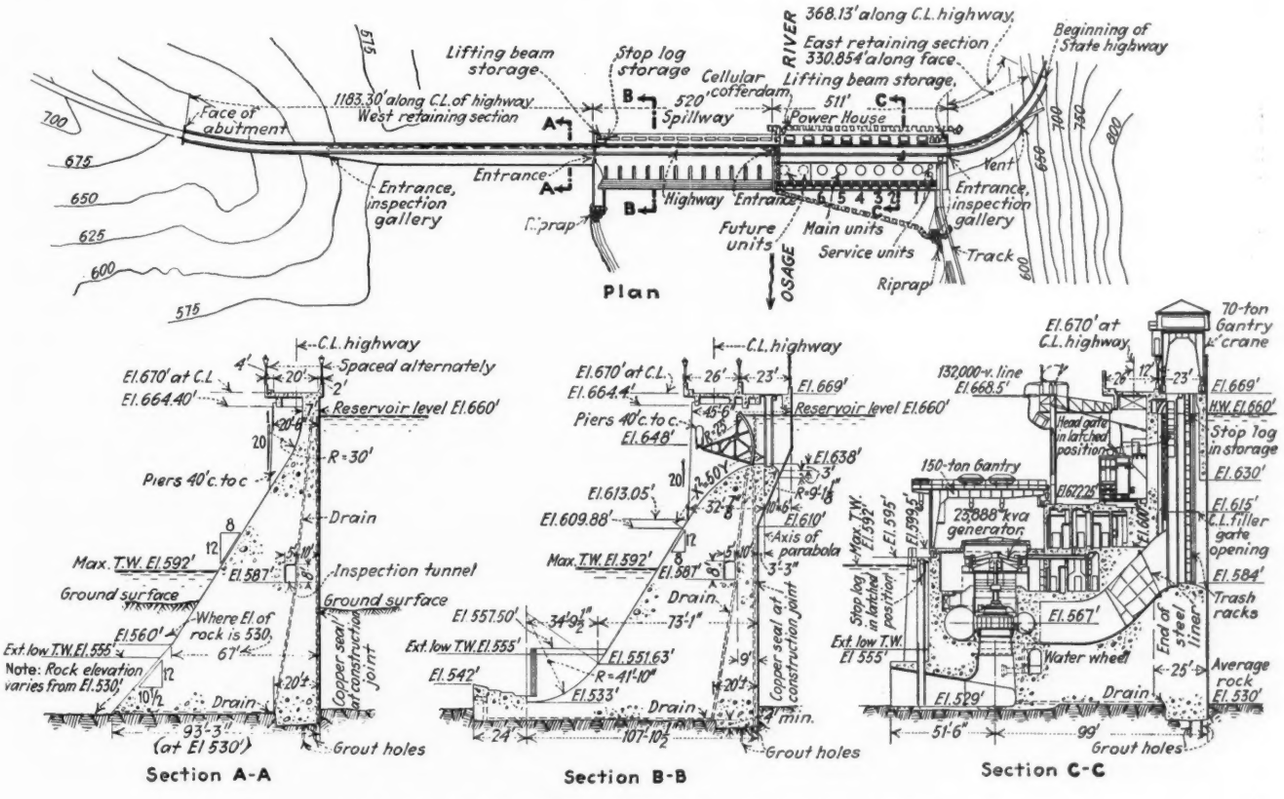
Above the power site the Osage River has a drainage area of about 14,000 sq.mi. and an average flow approximating 10,500 sec.-ft. For many miles upstream the river is flanked by steeply rising bluffs which form the shore line of the "Lake of the Ozarks" reservoir extending over several counties for a distance of 129 miles. Covering an area of 95 sq.mi., or about 61,000 acres, this reservoir will store 87 billion cubic feet of water, of which 52 billion will be available for power.

The development consists of a concrete dam of gravity section, a power house built integral with the dam, and the transmision line systems previously mentioned. The dam is about half a mile long, one-fifth of the length being used as a spillway, one-fifth for the power house intake and the remaining three-fifths being of solid bulkhead construction. A roadway serving as a river crossing at this point surmounts the dam, and an inspection tunnel is built into it from end to end.

On the spillway and power house intake portion of the dam, space in addition to that necessary for the highway must be provided for gantry cranes to operate the gates and stop logs. Flow over the spillway is regulated by twelve taintor gates operated by 70-ton gantry cranes.

In the power station the initial installation will consist of six main units, with space for two future main units and two station-service units. No superstructure will be provided other than an individual metal inclosure over each generating unit.

Head gates for each main unit will be of structural steel, 27 ft. wide and 27 ft. high, of the fixed-roller type. For unwatering the intake of any unit, arrangements will be made to replace vertical trash racks by stop logs. A motor-operated rake will clean the trash-racks. A concrete skimmer wall extending 30 ft. below the maxi-



Plan and typical sections of hydraulic structure and station

Summary of Data on the Osage River Project

Engineers and constructors.....Stone & Webster Eng. Corp.
Location of power station and dam, Osage River, 4 mi. above Bagnell, Mo., 136 mi. from St. Louis, 121 mi. from Kansas City.

Stream flow: Drainage area at dam, 14,000 sq.mi.; estimated max. flow, 145,000 sec.-ft.; max. recorded flow, 110,000 sec.-ft.; min. recorded flow, 324 sec.-ft.; average flow, 10,500 sec.-ft.

Reservoir: Area, 95 sq.mi., or 61,000 acres; length 129 mi.; length of shore line, 1,300 mi.; total water impounded, 87 billion cu.ft.; available reservoir capacity with max. reservoir drawdown of 30 ft., 52 billion cu.ft.

Head: Design net head, 90 ft.; max. net head, six units operating, 94 ft.; min. head under drawdown, 65 ft.; min. head under flood, 68 ft.

Dam: Length, including headworks, 2,543 ft.; spillway section, 520 ft.; abutment sections, 1,512 ft.; headworks section, 511 ft.; max. height bedrock to highway, 148 ft.; max. width of base, spillway 131 ft. 10½ in., abutment 93 ft. 3 in.

Crest gates, 12, taintor, 22 ft. high, 34 ft. wide; weight of each 27 tons; discharge capacity, 13,500 sec.-ft., Mississippi Valley Structural Steel Co.

Head gates, main units 8, fixed-roller type; 27 ft. high, clear opening 26 ft.; 27 ft. wide, clear opening 23 ft.; weight of each, 70 tons.....M. H. Treadwell Mfg. Co.

Head gates, service units 2, fixed-roller type; 13 ft. high, clear opening 12 ft. 6 in.; 11 ft. wide, clear opening 7 ft.; weight of each, 10 tons.....M. H. Treadwell Mfg. Co.

Gate hoists, two 70-ton gantry cranes serving head and crest gates .....Whiting Corp.

Power station gantry crane, 150 tons.....Whiting Corp.

Structural steel, trash-racks, stop logs and generator covers .....Stupp Bros. Bridge & Iron Co.

Roadway on dam, 20 ft. wide, 3-ft. sidewalk.

Power station: Initial length, 395 ft.; ultimate length, 511 ft.; width including headworks, 150 ft. 6 in.; height from bottom of draft tube to highway, 141 ft.; initial installed capacity, 201,000 hp.; ultimate 268,000 hp.

Main units, initial number, 6; ultimate, 8.

Waterwheels, 22,500 hp. capacity at 90 ft. net head full gate; expected efficiency 92.5 per cent at 90 ft. net head; max. discharge of water, 4,000 sec.-ft. per unit, Allis-Chalmers Mfg. Co.

Generators, 23,888 kva., 13,800 volts, 60 cycles, 3 phases, 90 per cent p.f.; efficiency 97.15 per cent; speed, 112½ r.p.m. .....Westinghouse Elec. & Mfg. Co.

Station-service units, 2; waterwheels, capacity of each, 3,025 hp. at 90 ft. net head full gate; efficiency 89 per cent at 90 ft. net head; max. discharge of water, 350 sec.-ft., Allis-Chalmers Mfg. Co.

Generators, 3,000 kva., 2,400 volts, 60 cycles, 3 phases, 70 per cent p.f.; efficiency, 95.3 per cent; speed, 327 r.p.m., Westinghouse Elec. & Mfg. Co.

Transformers, main units, single-phase, self-cooled with emergency air-blast cooling; 10 units, 3 banks of 3 each, 1 spare; capacity of each, normal 13,333 kva., with air blast 20,000 kva.; voltage 13,800 delta to 132,000 Y, General Electric Co.

Future transformer, station service, 3-phase, self-cooled, one, 3,000 kva.; 13,800 to 2,400 volts.

Station output, estimated average annual, 400,000,000 kw.-hr.

Transmission lines:
- Osage-Page Ave., one circuit, 136 miles long; conductors, aluminum, steel reinforced, 336,400 c.m., horizontal arrangement, wood pole H-frame support.
- Osage-Rivermines line, 2 circuits, 120 miles long; conductors, copper, 250,000 c.m., vertical arrangement; support, double-circuit steel towers with hinged wood arms.

Copper conductor.....Anaconda Wire & Cable Co.
Aluminum conductor .....Aluminum Co. of America
Transmission towers (steel).....McClintic Marshall Co.
Insulators and hardware.....Lapp Insulator Co.

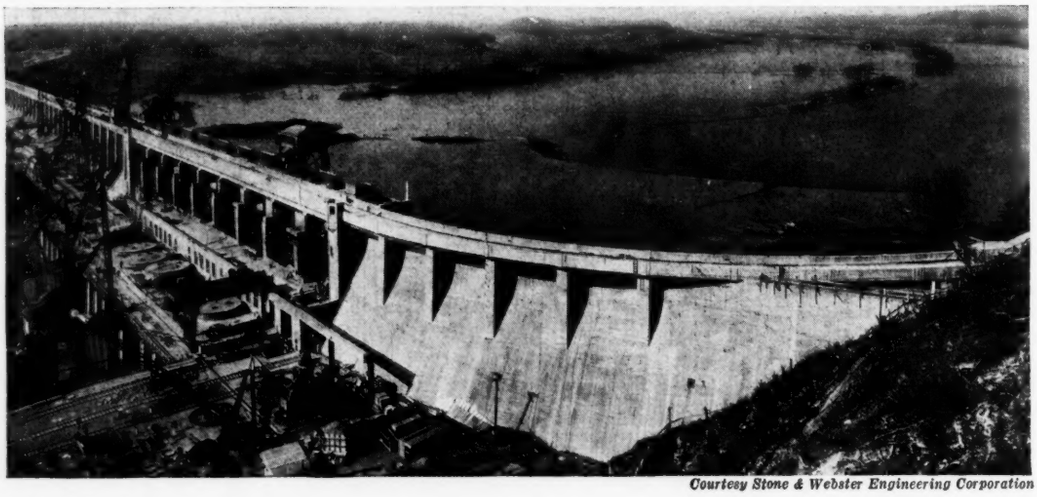
mum head-water level will be constructed as an integral part of the headworks.

For each main unit the prime mover will consist of a 33,500-hp. vertical-shaft francis-type waterwheel designed to operate under a normal net head of 90 ft. and at a speed of 112.5 r.p.m. Generators of umbrella type rated at 23,888 kva. will deliver 3-phase, 60-cycle current at 13,800 volts. These machines will be equipped for closed air circulation with two water coolers per generator. Auxiliary power will be supplied by two 3,025-hp. vertical-shaft station-service units.

For the initial installation there will be three 60,000-kva. main power transformer banks, each consisting of three single transformers from which a rating of 20,000 kva. will be obtained by aid of air-blast equipment. Initially, a pair of two generating units will be connected through their respective generator oil circuit breakers to each 60,000-kva. transformer bank, the latter being connected directly to the transmission line without high-tension oil circuit breakers. Provision is made for a future sectionalized 13,800-volt station bus to which four of the eight generating units will be connected, with the connections for each of the four remaining generating units forming a generator-transformer-line unit, each with a tie connection to the bus.

Essential station auxiliaries will receive power at 2,400 volts from a single bus system divided into three sections, with each of the two 3,000-kva. waterwheel-driven generators connected to an end section of the bus and ultimately a 3-phase, 13,800-to-2,400-volt transformer connected to the center section of the bus. The smaller auxiliaries will receive power at 460 volts through two banks of 2,400-to-480-volt transformers.

Construction work on the project is being pushed night and day. About fifteen months from the time excavation was begun, the dam and the power house structures are virtually complete, so with rapid installation of equipment, the Osage development will be ready well ahead of schedule to take its place with the other two components of the system.



Courtesy Stone & Webster Engineering Corporation

Bagnell Dam, on the Osage River, will create a reservoir of 87 billion cu.ft. capacity, of which 52 billion cu. ft. will be available for power generation

"Power-Mindedness" Needed By Industrial Executives

By R. J. GAUDY

Executive Engineer
Sessions Engineering Company, Chicago

When power is the chief executive interest, as in the utility field, progress is the result. But what is to be the future of the great number of plants serving institutions and industrials? Will it be sufficient for the executives to be guided by the assurance of employees that the best possible is being accomplished with the present set-up, or shall management, learning of the unquestioned economies that are possible, embrace a highly developed power program or adopt some intermediate plan.

ADMITTEDLY, in the majority of industries, power is not the prime consideration. Economies are possible, however, in the services to the industrial which give to the company obtaining them a decided advantage. As the volume of business increases, and the prices tend to hold fast, the greater income will fall into the hands of those whose manufacturing and service costs are the least. In certain industrials it is possible to make as much money through these economies as is represented by half of the normal dividends. Spurred on by these possibilities the average industrial manager may adopt a program that will overburden his capital structure, so that he may not be as well off as the industrial manager adopting an intermediate program conforming with existing conditions.

To the industrial manager the power house almost universally presents a vague picture. If the head of the foundry is careless enough to allow castings foul with core sand to be delivered, the manager knows it; but apparently he never knows if the head of the power house is permitting scale on the boiler tubes to cut a larger slice out of his gross revenue.

If a department head degrades material in handling products, a big conference is imminent. If the power house degrades the valuable commodity represented by its fuel, with needless combustible in the ash, it is probably never known, and in any event receives little attention. The money consideration may be equal, but the management universally is more interested in product than in ashes. If an accident occurs to manufacturing equipment, everyone is fully interested in recovering the situation. An interruption in the power supply usually is considered as that "cussedness" inherent with power houses.

It is evident that the management should give as much attention to the power house as to the manufacturing process, inasmuch as, man for man and dollar for dollar, the power-house effort may prove more valuable.

Best results will be obtained by attacking the problem from an economic basis. The elements with which the management must work are stated, for convenience, as follows: capacity capital, inducement capital, buying skill, attendance expense and operating insight.

Capacity capital is the investment necessary to supply the required water, air, heat, energy and steam with continuity and at the rate at which it is used. Inducement capital is that added investment in water treatment, boiler control, bleeder turbine features, heat exchangers and more efficient equipment generally, which by reason of the savings possible, are the inducement for this added investment.

Buying skill, in the sense that it is used here, is not related to the purchase of the plant apparatus as much as to the continual supply of fuel and other expendible items. Many plant engineers are firing coal unsuited to their equipment because it has been forced upon them through lack of application of sufficient buying skill on the part of the management.

Attendance expense, like capacity capital, is that basic cost in payroll for manning the plant to maintain continuity of service and repair. Operating insight is the quality giving the additional skill in load dispatching, fuel conservation and preparation against changes in load conditions that will effect a net saving over the cost of employing the skill.

There are few power plants wherein the management is sufficiently skilled in the economic problems to justify a wholesale adoption of the latest developments that add economy under the technical supervision and management common to the public utility. It is the writer's belief, however, that almost every power house will justify complete modernizing, including the use of higher pressures. Economies from the use of byproduct power will be forced, as the management overlooking these possibilities will be at a business disadvantage. Co-operative arrangements with the public utility are attractive and contain no insolvable problems.

The first duty of the manager is to determine what can be done toward improving operation with equipment and conditions as they exist. This effort will show the necessity for the application of reasonable inducement capital and justification of operating insight when the thorough investigation toward modernizing is made. The cost of such an investigation, with the resulting demonstrated inducement capital, almost universally will make a more attractive return than improvements in any other part of the industrial. The destiny of the power house will depend largely upon the interest taken by the management.

Unless given the support of the management, which has the ability available in the skilled engineer, the power house in this competitive market will go into the discard as an adjunct to an industry being outdistanced by its competitor. To keep the power house development parallel with that of other departments, the industrial manager must see that the best is done with what is available, improve to the point of maximum economy, provide support or assistance to the operating staff in eliminating avoidable losses, make a serious analysis of

the byproduct power possibilities, modernize the plant to the maximum pressures, and initiate improvements and auxiliary replacements that will be suitable to the loads to be handled.

Some of the outstanding items that should occupy his first attention are byproduct fuel, boiler control, water treatment, evaporators as isolated steam generators, steam accumulators, preheaters, bleeder turbines, space heating with circulating water, use of high-heat-level economizers, superheat, and delivery of industrial heat loads with other vapor vehicles than steam.

To summarize, power plants will improve as rapidly as the insight of the management can be attracted to the possibilities, and to the employment of the skilled engineering that is available. From its present condition the business of servicing industrials may be counted upon to yield a handsome return for all of the effort and inducement capital turned toward its modernization.

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Comparison of British and American Diesel Costs Reveals Close Similarity

THE REPORT on heavy oil engine working costs for 1929-30, prepared by the British Diesel Engine Users Association, contains a number of valuable tables, some showing the average operating costs in itemized form, for a period of eight years.

Using the data given in the report, three charts have been prepared showing the variation of fuel oil and lubricating oil consumption per kilowatt-hour generated. These values have been plotted against the associated expression "running plant load factor." As this is equivalent to the term "running plant capacity factor" employed by the Diesel Power Committee of the A.S.M.E., it is possible to check the performance of the British plants against that of those American plants reporting to the Diesel Power Cost Committee. In Fig. 1, the English plants are shown, along with curves of the Diesel Cost Committee's report. In almost all instances the English plants fall within the zone bounded by these A.S.M.E. limiting curves.

On the other hand, the lubricating oil consumption of the British plants is somewhat higher than the average recorded by the A.S.M.E. committee. Probably one reason for this is that, as indicated by observations in the diesel engine users' report, many of the British plants had indifferent lubricating oil filter equipment or none at all.

The criticism often expressed, that a single-year's record is not conclusive, or even indicative, is answered by the inclusion in the report of the average cost in eighteen plants over a period of eight years. These data have been used to plot the average fuel consumption and the 1929-30 fuel consumption for the various plants against the running plant capacity factor, in Fig. 3. Apparently, no real increase in fuel consumption has occurred during the period of operation.

In the charts the plants are given numbers to permit comparison of the fuel and lubricating oil results. Likewise, the air-injection, mechanical-injection and the high-speed engines are given different symbols to permit, if possible, of a comparison on the basis of engine type.

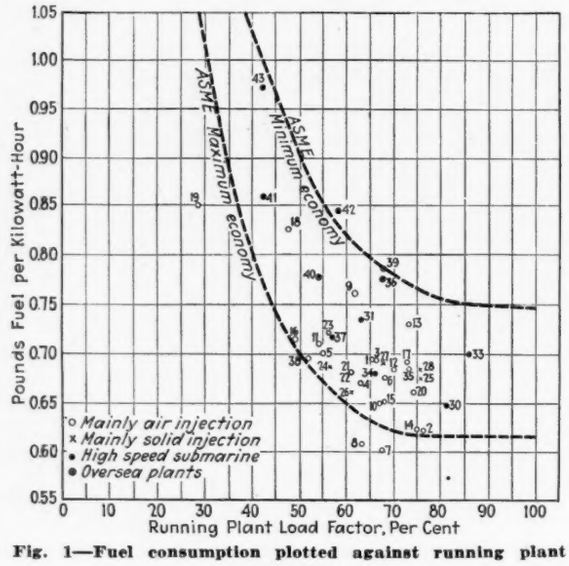


Fig. 1—Fuel consumption plotted against running plant capacity factor

RESULTS IN BRITISH DIESEL PLANTS, 1929-30

	Mainly Air-Injection Engines	Mainly Mechanical Injection Engines	High Revolution Ex-Submarine Engines
Number of stations	23	6	3
Total number of units generated	29,784,509	7,677,477	6,634,690
Total number of engines	89	28	12
Engine-hours run	199, 486	59,011	14,177
Average number of hrs. run per engine	2,240	2,108	1,180
Total capacity of oil engines. kw	23,513	5,673	6,250
Average capacity per station, kw	1,000	945	2,083
Maximum simultaneous load carried on oil-engine plants, kw	18,799	4,189	5,497
Running plant load factor, per cent	64.5	61.8	74.9
Average fuel oil cost per ton	$19.25	$16.22	$17.55
Average lubricating oil cost per gal	$0.64	$0.55	$0.81
Average fuel oil consumption per unit generated, lb	0.682	0.692	0.678
Average lubricating oil consumption per unit generated, gal	0.00132	0.00141	0.00274
Average rated b.hp.-hr. run per gallon of lubricating oil	1,765	1,715	732
Average Engine Cost per Kilowatt-Hour Generated:			
Fuel	$0.580	$0.494	$0.524
Lubricating oil	0.084	0.078	0.218
Water and stores	0.032	0.028	0.064
Wages, (running staff)	0.296	0.240	0.168
Repairs and maintenance (including labor)	0.170	0.194	0.714
Total	$1.162	$1.034	$1.688

Note: The original values in pence have been converted into cents at the rate of 1d. = 2c.

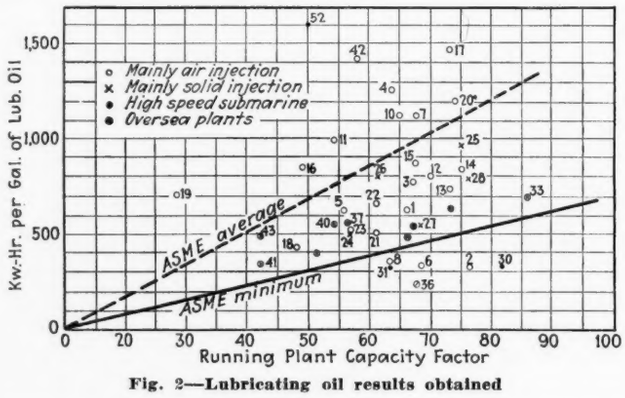
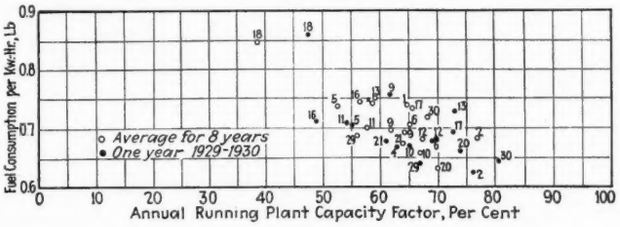


Fig. 2—Lubricating oil results obtained

There seems to be but little advantage inherent in any particular engine design.

As shown by the table, which gives the group average results, the mechanical-injection engines had a fuel oil consumption slightly higher than did the air-injection units. But the lowest of the three averages was obtained from the high-speed engines, explainable in part by the better running plant load factor.

The submarine engines, which were taken from German submarines and rebuilt in land engines, however, had a lubricating oil consumption almost double that of either of the other two classes. The marked difference in the costs per ton of the fuel oil used in the mechanical-injection and in the air-injection engines



Low heating element is removed from the casing inclosed in the wall

justifies further explanation by the association. Experience in America with the two types of engines would not lead one to expect the air-injection engine to require a higher quality of fuel.

The rather high wage cost per unit generated is due to the character of the plants' loads. Many of the plants operate in conjunction with a transmission system, or bulk supply, and are run only at peak periods, which make the labor charge high. While the several plants gave results by no means consistent, nevertheless the averages may be used, with discretion, as indicative of values obtainable from any plant operating under the same load conditions.

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A Pawlikowski Coal-Dust Engine Tested in Czechoslovakia

A LICENSEE of the Rupa motor, in Brunns, Czechoslovakia, has built and tested the first of these coal-dust engines to be manufactured outside the Kosmos (Germany) works of the inventor, R. Pawlikowski.

This single-acting four-stroke-cycle engine has one cylinder 19.68 in. diameter and 28.35-in. stroke, with a normal rating of 140 hp. at 166 r.p.m. A three-stage injection-air compressor supplies the injection air.

The engine was operated on the test block under load provided by a Froude brake 10 to 14 hr. daily for a total time of about 700 hr., including three non-stop runs of 31-, 72- and 80-hr. duration, respectively.

Central German 9,000-B.t.u. brown coal, with an initial mine moisture content of 55 per cent, was used as fuel; this moisture was reduced to 10 per cent at the mine in rotary driers by exhaust-steam heating. At this moisture content the coal disintegrates into a powder upon exposure to air and requires no grinding. Its compotion is as follows: Oxygen, 19.9 per cent; nitrogen, 0.6 per cent; sulphur, 0.9 per cent; hydrogen, 4.9 per cent; carbon, 55.2 per cent; and ash, 8.1 per cent. The ignition temperature is 444 deg.; the volatile, without H_2O 43.4 per cent.

The fineness of this brown-coal powder is indicated by the fact that 67 per cent passes a 300-mesh screen, and a 200 mesh retains but 9.5 per cent.

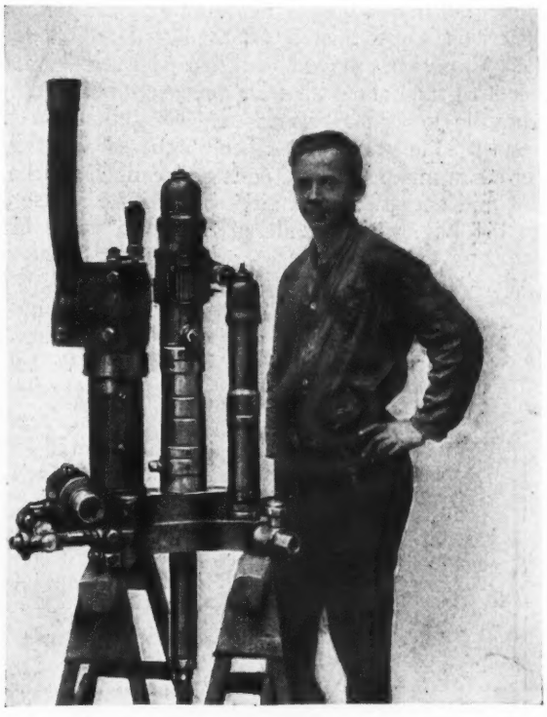
The results of the engine tests are given in the table.

Load	Mechanical Efficiency, Per Cent	Pounds of Fuel per B.Hp.-Hr.
¼	31	2.050
½	50	1.2789
¾	64	1.0143
Full	73	0.882
1¼	79	0.8379

Unlike all the coal-dust engines previously built, this seventh Rupa engine has no fuel oil pump to permit the engine to be started on fuel oil. Ignition on coal took place uniformly at all loads. A compression of 594 lb., somewhat higher than that in Diesel engines, was carried at full load; the maximum pressure was 653 lb. and the m.i.p. was 162.2 lb. at 295 hp., corresponding to a maximum load of 220 b.hp.; that load, however, could be carried for short periods only, because the bearings of this otherwise standard-type diesel engine had been designed for only 160 hp. maximum load, and consequently ran hot at the overload of 220 horsepower.

The amazingly high maximum m.i.p. of 162.6 lb. was obtained without supercharging, and was made possible by the high (20 per cent) oxygen content of the brown coal, which thus carried part of its own oxidizing agent.

Measurements showed that the piston consumed 0.00882 to 0.01323 lb. of lubricating oil per brake horsepower-hour. When centrifugal oil purifiers are



The coal-dust injection apparatus of the Rupa Motor

used, the oil consumption is expected to shrink to 0.003075 pounds.

The upper end of the cast-iron cylinder liner showed a wear of 0.149 in. after a total of 55,125 lb. of brown coal was consumed in the tests. Replacement by a new hard-steel liner appears to be logical and economical.

When the cylinder cover was lifted after the 700 hr. of operation, no deposit of any kind was found inside of the working cylinder.

Burning Wood Refuse With Coal

The problem of burning wood refuse from mill operations has been worked out in several different ways. This article describes a method used in the power plant of an automobile body factory located in Southern Indiana

By G. A. HOLMES

IN AN Indiana automobile-body factory the power plant consumed the refuse resulting from mill operations on approximately 60,000 board feet of lumber daily. Experience has shown that between 30 and 40 per cent of the lumber entering the rough mill eventually reaches the power plant as refuse. The actual percentage varies with the grade of lumber purchased and the care observed in making use of odds and ends from the different mill operations. A large part of the refuse came from the hog, which rendered the large waste blocks, strips and floor sweepings into shreds that could be handled through the blow-pipe system. The balance of the refuse consisted of sawdust removed by the blower system connected to each mill machine.

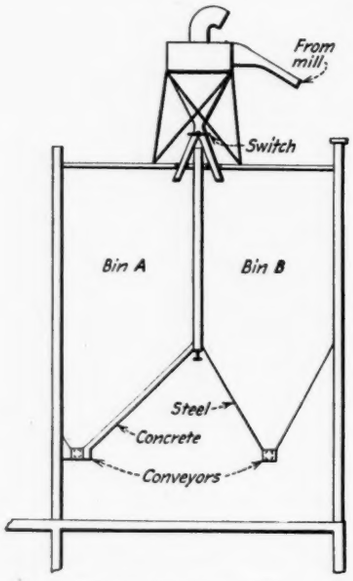


Fig. 1—Designs of the two bins used

The factory being in the Southern Indiana coal mining district, it was economical to use coal from this vicinity. Mine run was obtained delivered at the plant for as low as $1.84 per ton. Nearly all coal from this district contains a large percentage of sulphur and iron impurities. The most satisfactory operating results were obtained with a coal of the following analysis: Volatile, 43.71 per cent; fixed carbon, 41.87 per cent; ash, 11.04 per cent; and sulphur, 3.38 per cent. The heating value was 12,454 B.t.u. and the fusion temperature, 2,100 deg. F.

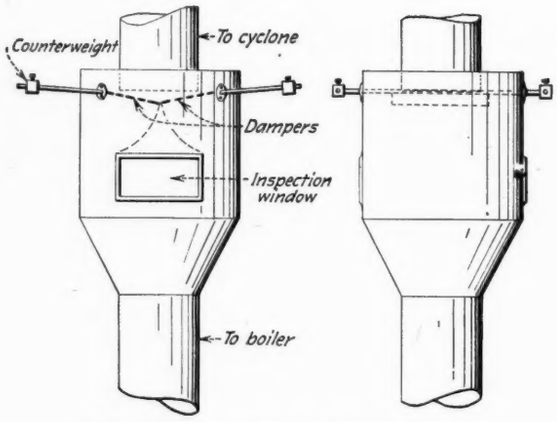


Fig. 2—Damper for the shaving pipes

The power plant consisted of two vertical bent-tube boilers of 5,120 and two of 3,500 sq.ft. of heating surface, all of which were equipped with underfeed stokers. The boilers supplied steam at 200 lb. to two non-condensing turbine-generators, one of 1,000- and one of 350-kw. capacity. In the winter exhaust steam was used for plant heating, and for lumber dry kilns and other process work during the entire year. In the summer months large quantities of exhaust steam were lost to the atmosphere.

The draft to the furnaces was supplied by blowers taking their air supply from the power house basement. Refuse was conveyed from the mill to the power house roof by means of a blower exhausting into a cyclone arranged to empty into either of two storage bins. The plant when first built had only one storage bin, which was built into the building and had brick sides with sloping concrete bottom and scraper conveyor, bin *A* in Fig. 1. This conveyor was driven with a variable-speed alternating-current motor, the controller of which was on the firing room floor.

Conveyors of the bins discharged into blowers, which deposited the refuse in the cyclone above the boiler room roof. From this cyclone the flow of the refuse could be

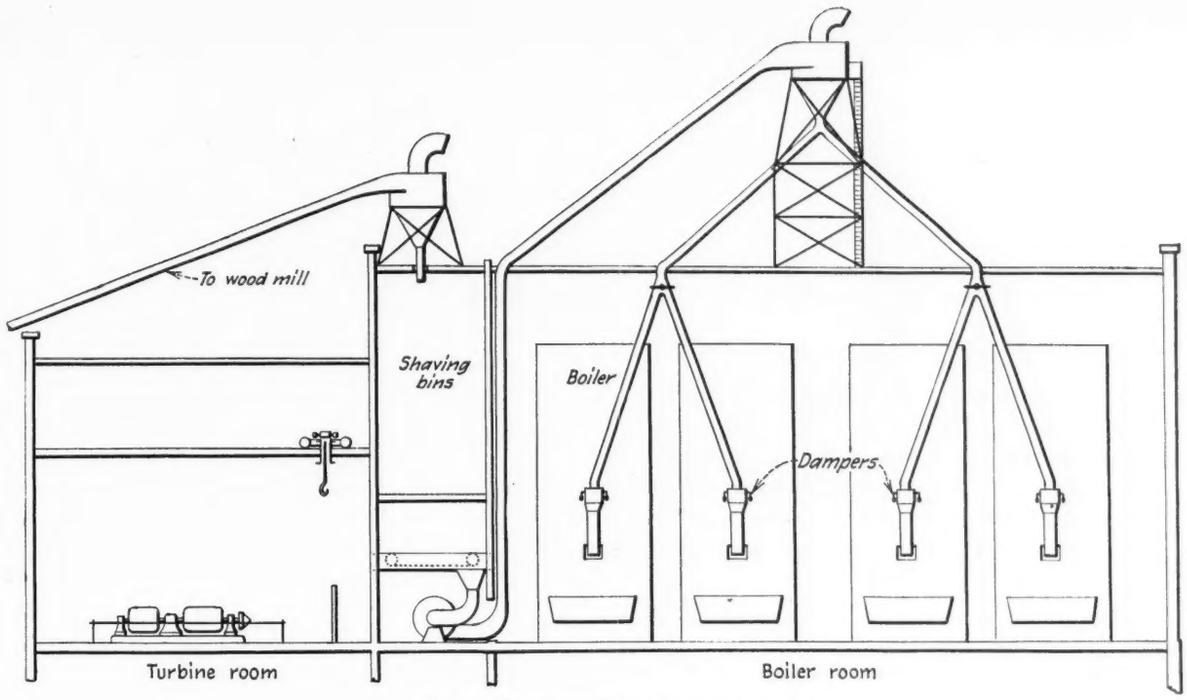


Fig. 3—Arrangement of fuel system

regulated, by means of switches, to either or all of the four boilers, the arrangement being shown in Fig. 3.

At a later date a second storage bin was constructed, with brick sides but steel plate bottom and scraper conveyor, *B* in Fig. 1. This conveyor was driven with an alternating-current motor connected to a variable-speed transmission, equipped with electric tachnometer and remote control and placed on the firing floor.

Just enough coal was burned to keep the grates well covered, thereby preventing their burning out, and, at the same time, as much of the boiler load as possible was carried with the heat developed from burning the refuse. For this reason it was found desirable to use a slow-burning coal, and all variations in boiler load were controlled by feeding more or less refuse.

With the variable-speed motor control on the shaving bin *A* shown in Fig. 1, it was impossible to maintain a close enough relation between the varying boiler demands and the rate of feeding refuse to give an economical furnace operation. The newer storage bin *B*, with the variable-speed transmission, permits the exact flow of refuse necessary for the particular demand on the boilers. A recording CO_2 indicator showed an excessive variation in the percentage of CO_2 from one reading to another, when operating the old equipment, whereas with the new control an even reading can be maintained.

The original storage bin also gave considerable trouble as a result of the refuse bridging over the conveyor, making it necessary for a workman frequently to enter the bins to break down the formation. The newer bin with steeper bottom and less friction, because steel plates were used instead of concrete, gives little of this trouble.

Flow of refuse down the pipes from the cyclone on the boiler room roof introduced a large quantity of excess air above the fire beds, as did the tendency of the stack draft to draw air in by the same path.

To reduce this to a reasonable quantity the device shown in Fig. 2 was installed on all the boilers. The counterweighted dampers in this device serve to allow a small quantity of refuse to build up in the pipe. They then open and allow the refuse to pass and close again, preventing the stack draft from drawing very much air in above the fires. This device also prevents the spreading of fires up the down pipes, which before the device was installed would often spread up to the cyclone on the roof. No trouble has been experienced with the device's becoming clogged.

It was found, after considerable experimenting, that 175 per cent excess air is necessary for good combustion of the two fuels, and to maintain freedom from grate trouble.

Experience also revealed that it is best to introduce the refuse as high as possible above the fire beds, in order that it will be distributed evenly over the entire fire bed and so that as much of the combustion as possible will take place in suspension.

The greatest difficulty experienced in burning these two fuels together is that of obtaining a slow-burning coal and at the same time one that does not clinker enough to cause burning of the grates.

Buying Coal for Profit

Often high efficiency is obtained at too great a cost in coal values. The shrewd coal buyer can save thousands of dollars yearly by intelligent co-ordination of coal market information and equipment capabilities. G. B. GOULD, president of the Fuel Engineering Company, of New York, will tell how, in four intensely practical articles.

The first will appear next week

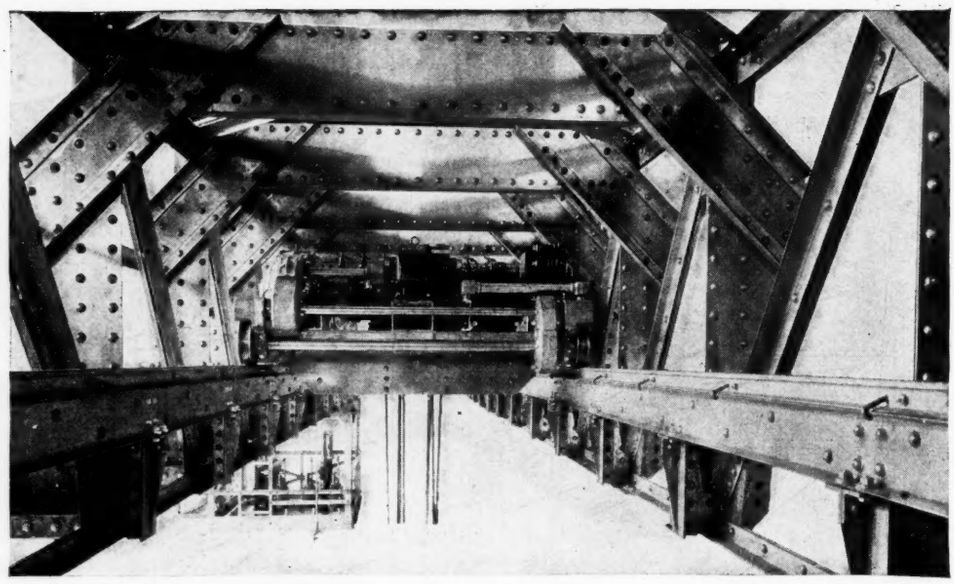


Fig. 1—Truss-type crane with trolley mounted on rail beams between trusses

Traveling Cranes Built of Aluminum Alloy

By E. C. HARTMANN
Aluminum Research Laboratories
Aluminum Company of America
New Kensington, Pa.

An unusual design of truss-type bridge traveling cranes built of structural aluminum alloy shows a large decrease in weight and has other desirable features compared to the plate-steel girder type. These aluminum cranes are for shop use, but they suggest possibilities in power-house and other applications, because of the truss design and light weight.

THE EIGHT CRANES recently completed for the United States Aluminum Company represent a marked departure from the conventional design for overhead traveling types. These cranes are built of structural aluminum alloys and have a truss-type bridge with a submerged trolley instead of the conventional box-girder bridge with the trolley mounted on top. They have 5- and 10-ton capacities and operate on various span lengths, ranging from 51 ft. 10 in. to 76 ft. 6 in. Two of the cranes were built by the Alliance Machine Company and the remainder by the Northern Engineering Works.

Prior to the construction of the truss-type cranes, a number of aluminum cranes of the conventional box-girder type had been built. These had shown a surprising weight saving over steel construction; however, it was thought that by using trusses in place of box-plate girders for the main supporting members of the bridge an even greater weight saving could be effected. Consequently a study was made jointly by the Aluminum Research Laboratories and the crane manufacturers to work out a truss-type construction having minimum weight and maximum rigidity. As a result of these studies two slightly different constructions were adopted, one by each of the two manufacturers. The type of construction described in this article was used by the Northern Engineering Works.

It was necessary in designing the truss-type cranes to consider both the clearance from the floor and the clearance from the roof. In other words, it was essential that the over-all depth of the crane be made as small as possible. This led to the adoption of the submerged trolley, which allowed the entire depth available to be utilized in the trusses, hence giving maximum rigidity and light chord sections. The submerged trolley also made it possible to use a complete system of top lateral bracing between the trusses, thereby providing greater lateral rigidity than could otherwise be obtained. The problem of mounting the submerged trolley between the trusses was solved by installing rail beams on a series of brackets at each panel point, as shown in Fig. 1. In order to take care of the eccentric loads produced by these brackets, a yoke construction of $\frac{1}{4}$-in. plates and angles was provided at each panel point and formed a part of the top lateral system already referred to.

The distance between the rail beam and the center line of truss was kept at a minimum by using a special trolley design having no outboard bearings on the wheels. This trolley, shown in Figs. 1 and 3, has a cast aluminum frame. The entire trolley is aluminized, with the excep-

tion of the wheels, axles and machinery parts. The eight electric contact rails for the trolley are attached to the under side of the top horizontal member of the yoke construction at each panel point, thereby giving a simple symmetrical arrangement of the contact shoes on the trolley. The walkway, drive motor and operator's cab are bracketed out from one side of the bridge, as shown in Fig. 2, and the complete bridge is framed into cast-aluminum trucks at each end.

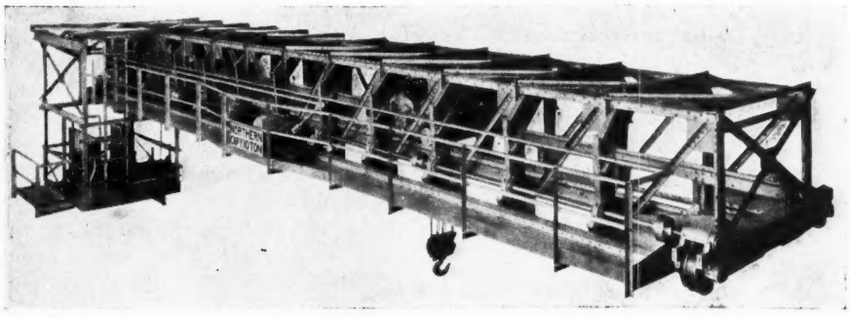
Structural members of the cranes were designed for the full dead load plus the rated capacity load on the trolley. In addition to this, a 50 per cent vertical impact effect and lateral loads due to acceleration and retardation were considered. The members are proportioned so that the stresses caused by the worst loading combinations do not exceed the design stresses given in the Structural Aluminum Handbook published by the Aluminum Company of America.

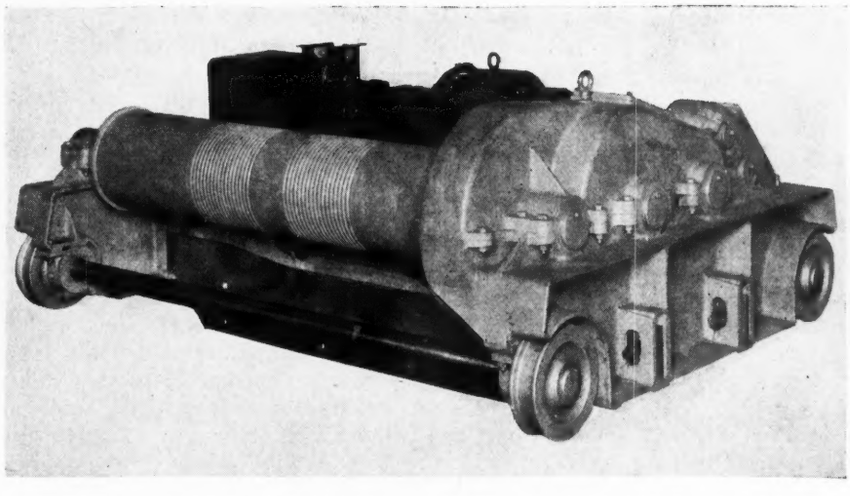
The cranes were riveted throughout with $\frac{3}{4}$-in. strong aluminum-alloy rivets driven hot at the heat-treating temperature. Contact of these rivets with the relatively cold metal adjacent to the hole provided an excellent quench that resulted in high mechanical properties in the completed rivet. The trusses were cambered to correct for dead-load deflection plus one-half the deflection of the rated capacity load at the center of span.

A 10-ton capacity crane operating on a 76-ft. span weighs 29,800 lb. complete. A conventional steel crane for the same span and duty will weigh approximately 76,000 lb., which indicates a saving of about 23 tons for the aluminum crane. It is estimated that if the aluminum crane had been made of the conventional box-girder type instead of the truss type it would have weighed approximately 40,000 lb. This means there is a probable savings of about five tons between the truss-type and the box-girder cranes. As a result of the light weight of the 10-ton, truss-type crane, it was possible to reduce the size of the bridge drive motors from 45 to 19 hp., with a corresponding decrease in power required for operation. Even with this decreased motor size the crane is very fast, especially in starting and stopping. Similar weight savings and attendant advantages were found in the case of the other seven cranes.

Load tests have been made on three of the aluminum truss-type cranes. Each crane was subjected to at least a 60 per cent overload, and readings were taken for both deflections and stresses. The maximum deflection recorded at these overloads was slightly over one-tenth of 1 per cent of the span length, which is negligible so far as the operation of the crane is concerned. In each case, it was found that the measured deflection was somewhat less than the deflection computed by ordinary methods used for trusses. It was found, however, that by applying a correction to this method to take into account the stiffening effect of the gusset plates the measured and computed deflections checked closely.

The measured stresses in the trusses were found to be somewhat smaller than the corresponding computed stresses. This was attributed to the stiffening effect of the rail beams and walkway, which, of course, would not ordinarily be taken into account in computing the stresses. The measured stresses in the rail beams indicated that the rails themselves were acting to a considerable extent as part of the rail beam, thereby noticeably reducing the bending stresses in the top flange. The bottom flange stresses checked closely with the stresses computed on the assumption of complete continuity over unyielding supports.





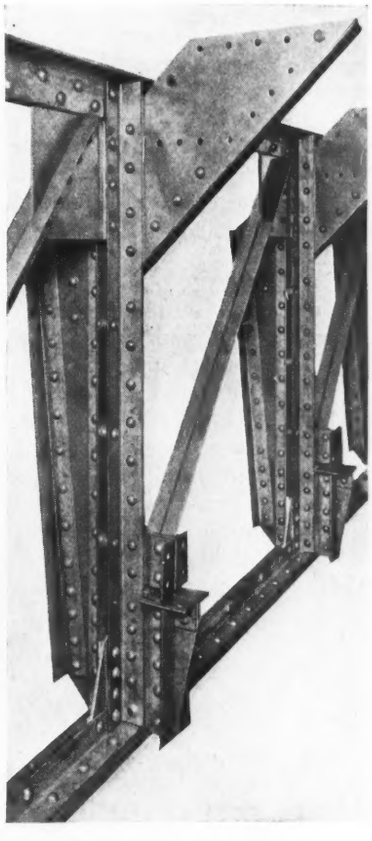


Fig. 2 (Above)—The crane bridge is framed into cast-aluminum trucks at each end
Fig. 3 (Below)—Ten-ton aluminum crane trolley with trolley wheels on outboard bearings

Fig. 4—Details of truss yoke structure and bracket to support trolley rail beams

As a Piping Engineer Views "Or Alternate" in Specifications

IN MANY of the largest buildings in this country, and particularly those in New York City, consulting engineers as well as engineers in architects' offices write plumbing, heating and air-conditioning specifications calling for certain grades of pipe and ask for alternate bids on cheaper grades. When the various bids are received it becomes necessary for the building committee, or the representatives of the owners, to decide whether to accept the higher bids or to save money on the contracts and accept the lower bids.

The final decision as to piping is usually far from what was originally intended and originally recommended by the engineers. When the bids on the subcontracts are received it is generally found that the cost of some or most of them is higher than the accepted estimates. It is usually thought necessary to cut down the cost of each subcontract so that it will approximate the estimate or equal it. Subcontracts are often regarded as separate entities and are not properly parts of the whole. For instance, in a building recently put up in a large city in the East the plumbing contract and the heating contract were found to run higher on bids than on the estimates. A separate subcontract for a vacuum-sweeping system was found to run well within the estimate. The building committee accepted cheaper piping materials than those recommended on the plumbing system, and let the vacuum sweeper system stand as specified with unnecessarily expensive piping materials in it.

It should be stated that brass pipe, wrought-iron pipe, steel pipe and cast-iron pipe all have their legitimate places in practically all important buildings. It is necessary for a specification engineer to consider two questions in writing every plan. The first one is: What kind of material can be expected to give the desired service over the expected life of the building? Secondly, what material can be secured most economically which will perform this service?

Replacements Are Costly

If a pipe fails behind a wall, the cost of another or any part of it, no matter how trifling it may be, always entails an expense out of all proportion to the cost of the renewed material. A leader line in a large building in a Western city failed a few years ago. New pipe for the line cost approximately $75. The entire cost of removing and installing the new one, including the expense of tearing out the walls to reach the failed line and then putting in new walls, was over $1,500. Within six months another line in the same building failed, and a similar expense was incurred for renewal. With proper piping materials in the original leaders, which would have cost less than $150 per leader, the expensive repair job could have been avoided. The renewal cost of one failure in one leader would have paid the entire difference in cost between proper materials and the improper materials installed.

This brings up the sharp difference between pipe and practically every other article of building construction. In most other articles where failure is a possibility the renewal of a defective unit necessitates only the expense of buying a new unit plus the labor of taking out the old one and installing the new. With pipe the renewal of a failed unit involves an expense because of destruction not only of valves and other parts of the plumbing or heating system, but also of unrelated parts of the building, such as walls and floors, and often costly permanent decorations.

Therefore, to construct permanent buildings, the specifying engineers must know what kind of pipe is proper for every line in the plumbing and heating and air-conditioning systems, and they should specify these without any alternates. Otherwise, they are shirking a responsibility which is clearly theirs and are forcing the building committee to decide between two materials.

Corrosive Effects Vary

Since the water supply of one city will differ from that of another in its corrosive effects, there are no standard piping specifications that can be properly applied in all cities. New York City and Boston waters are probably as corrosive in hot-water lines as any in the country, because of their lack of calcium and magnesium salts in solution. These salts gradually precipitate on the walls of the pipe and generally form a tightly adhering scale in combination with the products of iron or steel corrosion. On the other hand, the formation of this protective layer of insulation cannot always be depended upon. This is the case in Pittsburgh, Pa., where there is more than sufficient salts in the water to accomplish the formation of a protective coating on the inside of the pipe.

In St. Louis the corrosive problem is a mixed one. The water has enough lime and magnesium salts to fill up hot- and cold-water pipes within 12 to 15 yr. after installation. Yet when the pipe is cleaned out with sodium silicate it is often found that it has corroded to a failure behind the deposit. This should caution engineers not to consider that a chemical analysis of water shows whether a water is severely corrosive in water or steam lines. Analysis of water is an indication, but only an indication. The only proof is to determine by inquiry and careful search just what pipe is giving service and what is not giving service in any city. The answer is there and it can be found.

In steam lines the most destructive waters in this country are those from the Great Lakes. Steam return lines in cities using waters from these lakes give considerably more trouble with improper pipe than do hot-water lines. The latter in these cities are not subject to very severe corrosion.

It can generally be said that, with certain exceptions, some of which have already been mentioned, the degree to which plumbing and heating lines corrode in the United States is about as follows, hot water being the worst:

1. Hot-water lines
2. Cold-water lines
3. Steam-return lines
4. Vents
5. Leader lines (down spouts)
6. Soil and waste lines
7. Steam-supply lines
8. Fire lines
9. Vacuum-sweeper lines

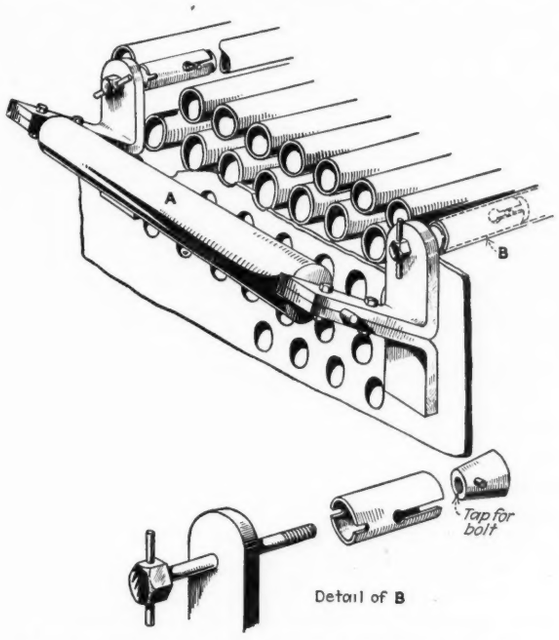
As previously mentioned, the various classes of pipe each have their place as an economic product in pipe lines in different cities. This matter should be clearly understood by all specification engineers, and they should write specifications calling for proper piping materials in each line, and without any alternates. If it is necessary to bring the bids within estimated costs, or to cheapen the whole building layout by changing the materials specified, piping materials are the last things that should be changed.

...RIGHT OUT OF THE PLANT...

Supporting Roll for Boiler Cleaner Hose

TO MAKE the task of running the cleaning tool through the tubes of fire-tube type boilers easier and to save the wear on the turbine hose over the edges of the tubes I have found the roller support illustrated useful and well worth the time of making and applying when the cleaning jobs are at hand.

It consists of a roll *A* of hard wood with a short shaft in each end made from lag screws with the heads cut off. The roll supports or brackets are made in two pieces and riveted or bolted together and then drilled for the shaft ends.



Roll support in place and detail of holding attachment

Details of the expanding plug for holding the device in place on the tube sheet are shown at *B*. A taper plug and a piece of split tubing together with the bolt are used and pins are put in as shown for holding the split tube against turning.

CHARLES H. WILLEY.
Concord, N. H.

Welding Boiler Joints

I WAS MUCH INTERESTED in the various discussions on the electrical welding of boiler seams that appeared in the Feb. 24 number. However, I do not believe that any of the discussions added materially to our information.

Leaky seams are not altogether results of poor jobs of riveting, but occur if the plates are not up metal to metal when the rivets are driven. This can, and does, occur very frequently, even though the boilers are supposed to have been built in accordance with the requirements of the A.S.M.E. Boiler Code. I find many cases of poor and sloppy workmanship on boilers bearing the standard stamps of different states. Not only are the makers of boilers to blame, but also the shop inspectors, many of whom I consider incompetent and unfit for the important positions they hold. There is no reason why the boiler in question should have developed leaks at the seams unless there was faulty workmanship and shop inspections.

I wonder just how carefully seams and rivets can be examined on a boiler already constructed and in operation. How can one tell if the plates were up metal to metal if the edges are calked? The rivet holes may not be reamed properly, rivets driven so as to fill the holes completely and burrs removed from between the plates prior to riveting.

Being in the field constantly and in direct contact with operating conditions, I have come to the conclusion that field annealing of welding, where done only for the purpose of tightness on a correctly designed seam, is not necessary.

I agree that welders may penetrate too deep, but a boilermaker calking the shell plate may spring the sheet and score the shell plate in taking a chip off of the seams. Common sense and correct practice must be followed out to the letter. We would have the shops filled with pressure vessels if we sent them in for heat-treating every time a minor repair of welding was made. I believe heat-treating should be dismissed in many cases of boiler repairs.

In regard to inside calking, evidently some of the discussors are not familiar with modern boiler construction. One stated: "Inside calking should be resorted to only for stopping local leaks along boiler seams." Apparently, he doesn't know that our leading water-tube boiler manufacturers calk the entire inside of their boiler seams and do no outside calking at all. This inside calking is to prevent, as much as possible, any likelihood of caustic embrittlement.

I wonder if there can be any slip of the riveted parts of a correctly designed and constructed seam; just how can this occur? Why do not all of our riveted and calked seams leak if this is the case? Surely, if there is any slippage at the seam, the calking edge has been disturbed and leakage must develop. Personally I do not believe this can be classed as an important factor in the leaks under discussion.

I do not believe that the weld need be considered of sufficient cross-section to serve as a structural element;

the necessary strength is there, in a properly designed and constructed seam, and the welding is for tightness.

New York State Boiler Code, Rule 827 (b) reads as follows: "Autogenous welding may be used in the repair of boilers in cases where the stress or load is carried by other construction which conforms to the requirements of the Boiler Code, and when the safety of the structure is not dependent upon the strength of the weld." The (i) section of the same rule also covers welding for tightness of patches properly riveted or fastened to the boiler. It is evident that this could be interpreted to read that seams could be welded for tightness only.

Any boiler inspector who is thoroughly conversant with welding and boiler construction would permit the seams to be welded, and the owners would not experience greater trouble in the future merely on account of the fact that the seams were so welded, nor would crystallization occur at the weld if the work was properly done.

I cannot agree that almost every mechanic or boilermaker can calk; few boilermakers are good calkers, although many of them attempt to do it. Not one out of every 100 other mechanics can properly calk boiler seams and rivets.

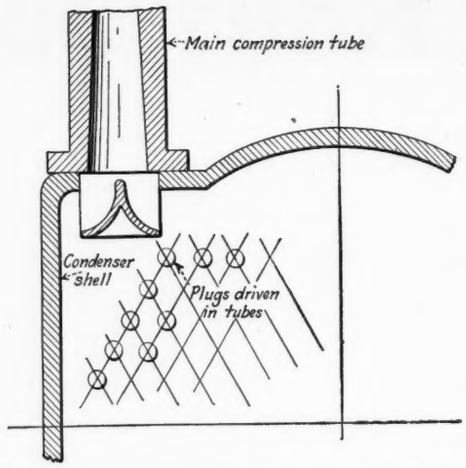
Might I suggest that anyone interested in welding and correct boiler construction secure copies of the A.S.M.E. Boiler Code or a copy of the boiler code used in his respective state. Literature and information may also be secured from the makers of welding equipment and supplies. We must keep up with the trend of modern boilermaking, for it is moving at a fast rate, and more and more we are accepting welding. I, too, was rather pessimistic about welding a short time ago, but have had to alter my views. Welding has come to stay. I do not anticipate it will be many years more before the riveted boiler will be a thing of the past.

Binghamton, N. Y. CHARLES W. CARTER, JR.,
State Boiler Inspector.

Temporary Repair to Steam-Jet Air Pump

WHILE I was operating a steam-turbine power plant for a coal mine company, some years ago, the vacuum on a barometric condenser used with one of the larger steam turbines fell back slowly from 28½ in. to about 26 in. A steam-jet air pump was used with the condenser, and we concluded that the trouble was due to one of the following causes: wet steam, too-high steam pressure, clogged strainers or nozzles, or a heavy deposit of scale in or on the nozzles.

We first examined the strainers, cleaned out the reducing valve and made a slight adjustment in the pressure. None of these things seemed to help, so it was decided to examine the after-condenser. When the heads were taken off the shell it was found that several tubes had been worn through by the impact of the steam, although there was a baffle at the discharge of the nozzle. This wearing action was probably increased by the steam's being wet, for although there were baffles in the main steam lines, at times the steam contained considerable moisture. The holes worn in the tubes reduced the capacity of the pump by filling the air chamber with water and also by creating a pressure against the nozzle discharge. It is probable also that considerable air was introduced into the chamber from the condensing water.



Section of after-condenser, showing tubes plugged

We had no repair parts or tubes in stock, so we plugged the tubes that were defective and one other tube that seemed worn down thin. The wood plugs were made slightly tapered and tight-fitting. When the pump was placed back in service the vacuum rose to its normal value. G. H. EMERSON.

Birmingham, Ala.

First Installation of 3,600-R.p.m., 15,000-Kw. Turbine-Generating Unit

I NOTED with interest in the Jan. 6 number a photograph showing on test "the largest 3,600-r.p.m. straight condensing turbine ever built."

It may be of interest to some readers to know that the city of Regina, Sask., Canada, installed and put into operation about June, 1930, a single-cylinder 3,600-r.p.m., 15,000-kw. steam turbine-alternator unit manufactured by C. A. Parsons & Co., Ltd., Newcastle-on-Tyne, England. This unit is designed for the same steam conditions as the one illustrated in the Jan. 6 number, namely, 450 lb. and 750 degrees.

Toronto, Ont. A. G. M. BROWN.

Pressure-Reducing Valves in Steam Supply to Engine

ALTHOUGH the principal use of pressure-reducing valves in steam lines is to render steam at boiler pressure available for the low-pressure requirements of heating apparatus and manufacturing processes, occasionally such valves are inserted in the steam supply pipes of reciprocating engines, the idea being to supply the engine at a constant pressure lower than the fluctuating boiler pressure. The valves are designed to maintain a uniform low pressure at the outlet irrespective of changes in the inlet pressure.

An instance of such use was in a manufacturing plant where the boilers delivered steam at a pressure of 200 lb. The main engine was supplied at this pressure, but it was found necessary to run an auxiliary engine with steam

at an initial pressure of 100 lb. The reducing valve in the steam line leading to this engine was of the diaphragm, spring-loaded type. The reduced pressure, impinging on an internal diaphragm, was automatically maintained constant by the resistance, transmitted through a toggle joint, of the external spring.

One day the auxiliary engine speeded up under almost full boiler pressure. An examination of the reducing valve showed that it was practically inoperative, owing to the bearings of the toggle mechanism having become fouled with rust and sooty deposits from the air. A liberal application of kerosene, followed by lubricating oil, into each of its movable joints, put the apparatus back in service.

The supreme test for a reducing valve in engine service is that not only shall the valve preserve the lower pressure while the steam is flowing through the engine, but that, when the steam is shut off on the low-pressure side, it shall keep the pressure from climbing on that side.

Reducing valves sometimes prove unsatisfactory in engine service because they are too large for the work required. If the velocity of flow past the seats is nine times the normal velocity in the pipe, an actual opening equal to about one-ninth the cross-sectional area of the pipe should be sufficient to pass the requisite quantity of steam. If the regulator is of such size that its lift must be scant to produce an opening no greater than this, and it is placed close to the engine, the valve disks will tend to open and close rhythmically with the admission and cutoff of the steam, and there will be a violent hammering on the seats. And even if the oversized regulator is set far enough away from the engine to minimize these pulsating effects, or they are avoided altogether by installing a receiver between the engine and regulator, so as to provide a cushion for absorbing them, there will be excessive wire-drawing through the slight openings and a consequent scoring of the seats.

There is no difficulty in reducing, in a single stage, from a high boiler pressure to any delivery pressure desired, provided the valve selected is suitable as to size and design. It is also important that a strainer be inserted on the inlet side. This is to protect the valve disks and seats against obstruction and injury by particles of scale and other foreign substances that may be picked up by the steam current.

A. J. DIXON.

St. Louis, Mo.

Light, Heat and Power Costs in Hotels

I HAVE READ E. C. ROMINE'S paper, "Heat, Light and Power Costs in New York City Hotels," in the Feb. 17 number of *Power*. The only part that makes any sense is headed "Recommendation for Metering and a Daily Check."

Reporting costs at so much per room sounds good, but does not mean anything. What is the total average income from the rooms or average income per day? Does the 150-room hotel per day average equal that of the 600-room hotel?

Is it reasonable to charge heat, light and power costs of kitchen and dining room against the number of rooms? The dining room and kitchen in many hotels consume a large quantity of light and in addition are self sustaining. Let us take Hotel No. 3 and do a little free and easy analyzing:

Item 1:	Kw.
Total current consumed	355,250
Total current sold	101,000
Balance charged to hotel	254,250

Item 2:	
Current sold	$7,000
Paid for stand-by current	1,680
	$5,320

Item 3:

This $5,320 is subtracted from cost of coal used by engines to generate 254,250 kw.:

Cost of coal	$7,383
Balance on Item 2	5,320
	$2,063

Balance of Item 3 plus unidentified cost of $1,519, plus $14,295 wages gives us a total cost of $17,942, against his $24,904, or a cost of $0.196 per room per day. This disregards cost of ice, which is not given, so we get 300,000 lb. free.

Jumping from Hotel 3 to 13 and 14, subtract payroll of Hotel 13 and 14, leaving balances of $35,300 and $32,553, respectively. The figure for Hotel 14, which generates its own power, is $2,747 lower.

To arrive at any satisfactory cost per room, the different conditions existing in each hotel would require far greater study than I imagine he gave this subject. Many items left out of his analysis should be added; in other words, half conclusions are no conclusions.

New York City. M. W. PALMORE.

Spontaneous Explosions in Cable and Pipe Conduits

IN MANY large industrial plants the electric cables and main pipe lines are run from one part of the establishment to another through subways on tunnels. The need of making provision for thorough ventilation of such subterranean passageways, particularly where they are connected by drainage channels to sewers or dumps, was exemplified by the occurrence of a rather disastrous explosion in a big conduit connecting the power plant of a manufacturing works with the main factory building. No loss of life or personal injury resulted, but the property damage was considerable. While the accident was attributed primarily to an accumulation of sewer gas, it was difficult to determine definitely just how the gas was set off.

Two of the principal constituents of sewer gas are methane, or marsh gas, and hydrogen. These gases are exceedingly combustible. Mixed with air in the right proportion, they will explode violently when fired by contact with a spark or flame. But in the case mentioned, evidence of the firing having been occasioned by an electric spark or a flame from some source was entirely absent. It would appear, therefore, that some combination of gases had taken place to cause a spontaneous explosion.

Special precautions should be taken to keep the inflammable gases from collecting. A continuous current of fresh air sent through by a conveniently installed blower will flush out the dangerous emanations from sewer openings and keep the atmosphere in the conduit safe and pure.

D. J. ALLISON.

Chicago, Ill.

From Among Readers' Problems

Conducted by
L. H. MORRISON

LAMPS HAVE SHORT LIFE—*What might be the cause of incandescent lamps burning out more quickly than they should? We generate our power with a 5-kw. direct-current generator driven by a gas engine. Could this trouble be due to defective lamps?* S.C.C.

The most likely cause of short lamp life is high voltage. The voltage of the circuits should be checked with a voltmeter that is known to be correct. The switchboard voltmeter may be reading low, and as a result the voltage of the system is maintained higher than it should be. A 5 per cent increase in voltage above rated value will decrease the life of Mazda lamps about 50 per cent. It is therefore evident that a small increase in voltage above normal on these lamps will cause a marked decrease in their life. The remedy for the trouble is to reduce the voltage to the proper value or use higher-voltage lamps. If they are of a recognized standard make it is very improbable that the trouble is due to defective lamps.

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LOW-PRESSURE TURBINE—*I should like to have your opinion on a low-pressure turbine operating at 80 lb. pressure. Can it be operated with a fluctuation of 10 lb. either way, the exhaust to be turned into a heating system. What economy could be effected on this fluctuation and pressure, and would there be any fluctuation in voltage?* H.Y.

It is possible to obtain a turbine to operate on 80 lb. steam pressure. A drop of 10 lb. would require that, to carry a given load, the governor must open wider. This new governor position is attained through a drop in turbine speed, which, however, should not exceed 4 per cent. The reverse action occurs at a rise in pressure.

If the fluctuations are rapid, the variation in turbine speed may be greater than this, depending upon the sensitiveness of the governor.

At 80 lb. initial pressure and 5 lb. gage back pressure, the steam consumption per kilowatt-hour would be in the neighborhood of 80-lb. per kilowatt-hour at the switchboard. This is based on the assumption that the turbine is under 300 kw. in capacity. Out of each pound of steam 77 B.t.u. would be transformed into electrical energy by a perfect turbine, and an actual turbine of this assumed capacity should show an efficiency of 65 per cent of that of the perfect engine.

HEAT USED BY INJECTOR—*What percentage of heat energy in the steam is used in forcing water into a boiler by an injector? Also, what is the difference between an automatic and a positive injector?* P.L.

The heat given up by the steam is equal to the heat given to the feed water plus the external work done. This external work of forcing the water into the boiler is about 2 per cent of the heat in the steam. The remainder, 98 per cent, of the heat in the steam reappears as heat in the water entering the boiler, so it is not lost. For this reason an injector, while an inefficient method of lifting water, thermally is an efficient boiler feed pump.

If an injector automatically resumes the forcing of water into the boiler after the steam or water supply has been discontinued and re-established, the injector is termed "automatic" type. If the injector must be adjusted manually to re-establish the water pumping after the steam or water supply has been discontinued and restarted, it is called a "positive" type.

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TUPPER GRATES—*We have an order for tupper grate bars. As we do not know what this bar is, we are unable to fill the order.* E.R.D.

The tupper grate is the herringbone grate in which the ribs are so placed between two side bars that the surface has the same appearance as the surface of a herringbone gear.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

IN CONNECTION with a pump bid it was necessary to figure the over-all water-to-wire efficiency of a combined unit consisting of a motor-driven vertical turbine pump and a horizontal centrifugal motor-driven pump. The turbine pump lifted the water to the surface of the ground and the centrifugal pump then lifted the water from there to an elevated tank. What formula can be used to figure this over-all efficiency when the brake horsepower of each pump at its flexible coupling and efficiency of each pump and motor are known?

THE OVER-ALL "water-to-wire" efficiency of the combined pumping unit is the ratio of the sum of the water-horsepower delivered by each pump to the sum of the electrical-horsepower consumed by each pump's driving motor. I assume that the following values are known:

Vertical pump shaft-horsepower $= P_v$
Horizontal pump shaft-horsepower $= P_h$
Efficiency of vertical pump $= E_2$
Efficiency of horizontal pump $= E_4$
Efficiency of vertical pump motor $= E_1$
Efficiency of horizontal pump motor $= E_3$

To find efficiency of combined unit E_c we may write the following equation:

$$E_c = \frac{\text{Total water-hp.}}{\text{Total electrical-hp.}} = \frac{(P_v \times E_2) + (P_h \times E_4)}{\left(\frac{P_v}{E_1}\right) + \left(\frac{P_h}{E_3}\right)} \quad (1)$$

The value for E_c will be a decimal, which is to be multiplied by 100 to give per cent. For example, let us substitute the following values:

Vertical pump shaft-horsepower = 30
Horizontal pump shaft-horsepower = 40
Efficiency of vertical pump, per cent = 65
Efficiency of horizontal pump, per cent = 70
Efficiency of vertical pump motor, per cent = 88
Efficiency of horizontal pump motor, per cent = 87

By substituting these values in the formula we get:

$$E_c = \frac{(30 \times 0.65) + (40 \times 0.70)}{\left(\frac{30}{0.88}\right) + \left(\frac{40}{0.87}\right)} = \frac{19.5 + 28.0}{34.1 + 46.0} = \frac{47.5}{80.1} = 0.593$$

West Lafayette, Ind. P. F. HOLLIS.

TO COMPUTE the over-all efficiency of a hook-up composed of two separate pumping units, one a motor-driven turbine pump and the other a motor-driven centrifugal pump,

HP_t = Motor brake horsepower at coupling of turbine pump.
HP_c = Motor brake horsepower at coupling of centrifugal pump.
E_{mt} = Efficiency of motor on turbine pump.
E_{mc} = Efficiency of motor on centrifugal pump.
E_{tp} = Efficiency of turbine pump.
E_{cp} = Efficiency of centrifugal pump.

In any process $Efficiency = \frac{Output}{Input}$

For this particular case $Efficiency =$

$$\frac{(Turbine\ pump\ output) + (centrifugal\ pump\ output)}{(Turbine\ pump\ input) + (centrifugal\ pump\ input)}$$

$$= \frac{[HP_t \times E_{tp}] + [HP_c \times E_{cp}]}{\frac{HP_t}{E_{mt}} + \frac{HP_c}{E_{mc}}}$$

This formula will give the desired over-all wire-to-water efficiency of the hook-up.

E. W. MacCorkle, Jr.,
Kentucky & West Virginia Power Co., Inc.
Ashland, Ky.

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IT IS ASSUMED that the level of the water in the well, river or reservoir from which the vertical unit pumps the water can be determined; that an accurate pressure gage is installed at the discharge nozzle of the horizontal pump; and that the quantity of water pumped is known, by means of an accurate flow meter, weir or measurement in the tank itself.

The total power absorbed by the water itself in horsepower is $P_w = \frac{GPM \times H_t \times 8.33}{33{,}000} = \frac{GPM \times H_t}{3{,}961}$, where

GPM = Flow in gallons per minute.
H_t = Total head.

The total head $H_t = 2.307 P + H_s + H_v$, where

P = Reading of pressure gage in lb. per sq.in.
H_s = Vertical distance in feet from surface of water in the well to the center of the pressure gage.
H_v = Velocity head $= \frac{V^2}{2g} = \frac{V^2}{64.4}$

V is the velocity of water in feet per second through the pipe at the point where the pressure gage is connected.

It would seem unnecessary to include a formula for the calculation of the velocity. But to make this complete, the velocity is

$$V = \frac{GPM}{60 \times 7.48 \times 0.7854\, D^2} = \frac{GPM}{352.487\, D^2}$$

where D = Inside diameter of the pipe at the point where the pressure gage is attached.

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Two Questions for Our Readers

1. I AM AN operating engineer, 48 years old, of at least fair ability. Due to a merger our factory is closed, throwing me out of a job. As I am over the economic age limit, should I seek engineering work or try something else?

A.P.C.

2. WHAT furnace volume should one use with a 1,500-sq.ft. water tube boiler, for 200 per cent rating, burning high volatile bituminous coal on an underfeed stoker? C.D.R.

Starting with this number, two questions will be offered to our readers, and not over three replies to each will be paid for[1] and published in the May 5 number.

▼

The total power, in horsepower, absorbed by the two motors is

$$P_t = \frac{P_v}{E_v} + \frac{P_h}{E_h}$$

where P_v = Brake-horsepower output of vertical motor.
P_h = Brake-horsepower output of horizontal motor.
E_v = Efficiency of vertical motor.
E_h = Efficiency of horizontal motor.

The combined efficiency of the whole system is then

$$E_c = \frac{P_w}{P_t}$$

This should answer the question as it is asked. However, it is most unusual to know the horsepower of a pump at its coupling. This is usually the most difficult thing to determine, and since the water-to-wire efficiency is what is desired, it is not necessary to know that figure. Instead, the power input to the motors could be measured more easily electrically and be very accurately determined, which would leave the individual efficiencies of motors and pumps out of the picture entirely.

While it is believed the above analysis will give the correct result from "wire to water," especially from the viewpoint of the operating man who must purchase a certain amount of power to pump a given quantity of water, the results thus obtained might not reconcile with efficiencies of the pumping units as usually considered by the deep-well pump manufacturers. These manufacturers generally do not consider the power loss of the water flowing through the drop pipe as a part of the turbine pump loss. When measurements of such pumps are made in the manner outlined, they usually credit the vertical pump with the same amount of power as would be lost in the flow of the same quantity of water through an ordinary pipe of the same size and length as the drop pipe, using the Hazen-Williams or other recognized pipe formula. This amount of power is deducted from the power input to the pump and the net result is used as P_v. It depends entirely upon whether one is interested more in pump efficiency or the cost of pumping water, which terms are not necessarily synonymous.

Earl E. Norman,
Dept. of Public Utilities.
Kalamazoo, Mich.

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IN APPROACHING the problem, it is first necessary to set up symbols to be used in the equations:

Let P_1 = Horsepower at coupling of turbine pump.
P_2 = Horsepower at coupling of centrifugal pump.
E_1 = "Wire to pump shaft" efficiency of motor driving the turbine pump.
E_2 = Efficiency of turbine pump.
E_3 = "Wire to pump shaft" efficiency of motor driving the centrifugal pump.
E_4 = Efficiency of centrifugal pump.
E = Over-all "water-to-wire" efficiency of the combined plant.

Then E = Total water horsepower output divided by total electrical horsepower input, or

$$E = \frac{P_1E_2 + P_2E_4}{\frac{E_1}{P_1} + \frac{P_2}{E_3}} \qquad (1)$$

If a small number of computations is to be made, this equation can best be simplified as follows: Let $R = P_2 \div P_1$. Then

$$E = \frac{E_2 + RE_4}{\frac{1}{E_1} + \frac{R}{E_3}} \qquad (2)$$

If a large number of calculations is to be made, the work of computation can be simplified by the use of two sets of curves. In one set, plot P_1E_2 and $P_1 \div E_1$ against P_1; in the other set plot P_2E_4 and $P_2 \div E_3$ against P_2. Then for any pair of values of P_1 and P_2 the desired quantities can be readily picked from the curves and substituted in equation 1.

It is assumed for the purpose of this discussion that the efficiency of the flexible coupling of the motor is included in the "wire to pump shaft" efficiency of the motor.

F. N. Calhoon.
Ann Arbor, Mich.

[1] As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired)
Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; Rietschel - Brabee's *Heating and Ventilation*; Annett's *Electric Elevators*.

Pumping Gas, Oil and Gasoline*

Average oil production of this country during 1929 was 2,755,000 bbl. of 42 gal. each, per day, or approximately 80,000 g.p.m. The bulk of this flow is pumped up to as high as 800-lb. pressure, not only once but as many as 20 times, to move it from the fields to its markets. In 1929 more than five billion cubic feet of gas per day was delivered through pipe lines. Lately, the movement of gasoline by pipe lines is being successfully carried out

By A. E. HARNSBERGER

Mechanical Engineer
Pure Oil Company

STARTING at the field, crude oil is generally collected at a central storage point, or tank farm, by means of a gathering system. The gathering pumps deliver to a tank farm, generally not over a few miles away. At this point the main trunk line starts, and here is located the first main line pumping station. These pumping stations are at intervals of from 30 to 100 miles along the route and at equal intervals except where elevation differences demand slight variations.

Practically all of the early pumping stations used steam for power, the earlier ones employing direct-acting steam pumps, the economy of which was aided by compounding. Later the crank and flywheel condensing pumping engines found favor and were built in both horizontal compound and vertical triple-expansion types. There were several reasons for the use of steam in the Pennsylvania fields. Coal for fuel was plentiful and cheap, and usually water for boilers and condensers could be easily secured. The oil engine was in a state of development and electricity was not then generally available.

Soon after 1900 the bulk of oil production shifted to the Mid-Continent area. Coal was of poor quality, transportation was expensive and water for condensers not always available; so this form of power found little favor. The diesel engine developed rapidly and soon found universal acceptance, since oil is cheap and a thermal efficiency higher than steam plants is obtainable. Cooling can be performed by means of a cooling tower, if fresh water is not available in large enough quantity, the make-up being provided from wells.

Standard construction for diesel pumping stations provides for a building divided into two rooms by a fire wall. Engines in one room drive the pumps in the other by extended shafts. The pumping equipment generally consists of either vertical triplex, or horizontal duplex or triplex plunger-type power pumps operating at pressures up to 800 lb., having capacities from 5,000 to 45,000 bbl. a day each.

During the last five years electric drives have been finding favor. The following factors have brought this about: While electric pumping, in spite of reduced rates, is still somewhat costlier than that secured by diesel power, electrically driven units have a lower first cost and require fewer operators. Also, the recent development of centrifugal pipe-line pumps of efficiency within a few per cent of that of power pumps further reduces station investment, which is a big factor in favor of electric drive when the life of an isolated oil field is unknown. Centrifugal pumps become too inefficient for main-line work below 25,000 bbl. a day. The largest units so far developed have a capacity of 60,000 bbl. per day. Another reason for electric drive is that recent improvements in continuity of service remove some of the former objections to it. Further, modern transmission methods apparently permit the power companies to extend their service to practically any part of the country.

Choice of oil engine or electric drive is thus a many-sided problem. In general, if the line is one that has many feeders, assuring a supply of oil for many years, the oil engine will prove the more economical. If the oil supply is from an isolated field and subject to a rapid decline, the electric drive is preferable. Between these extremes lie most of the actual cases, where such factors as first cost of pumping stations, value of crude oil to be pumped, electric rates and continuity of service must be carefully considered before making a decision.

Natural-Gas Transportation

The past five years have seen a tremendous increase in the mileage of natural-gas lines employed in this country. Gas companies are being interconnected, operating similar to superpower companies and extending to every state in the Union. The size of the lines has increased from 18 to 26 in. and the length from 100 to 1,000 miles. Operating pressures have increased from 350 to 600 lb., permitting a flow of as high as 200,000,000 cu.ft. per day through a single line. At present approximately 80,000 miles of natural-gas trunk lines are in use in this country, representing an investment of several billion dollars. In 1930 alone it is estimated that a quarter of a billion dollars was added to the foregoing investment.

Direct-connected gas-engine-driven compressors of the twin-tandem type are being used almost universally for pumping gas. There are several notable installations of steam-driven machines; but steam can be economically employed only when large volumes of gas are to be pumped, in combination with cheap coal and where a large stream of good water is available for condensing and boiler-feed purposes.

Gas lines, like oil lines, are laid on the shortest possible route, and the compression stations must be situated at definite intervals. Therefore they rarely occur at points where natural watercourses are available.

Higher Pressures Favor Steam Drive

Steam units employed are of the reciprocating cross-compound condensing type. There is in successful operation one steam-turbine unit driving a reciprocating compressor through reduction gears. The rapid development of turbines operating on high-pressure and high-temperature steam at high thermal efficiency should cause more interest in this type of drive in the near future.

The centrifugal compressor has not made much headway to date, principally because of the much lower compression efficiency through the range of variable pressure and capacity conditions encountered in the service.

There are no large electric-driven compression stations in trunk-line service at this time, although it is reported that an initial motor-driven installation soon will be made. Safety of operation would demand drive through a fire wall, which, if anything, would add to the cost of the building. Furthermore, jacket water for the compressor cylinders, and water for cooling the gas before it enters the main line, must be provided regardless of whether the station is gas-engine or electric driven. This means that a cooling system must be provided in either case. It is also doubtful if electrically driven pumps, could operate with a fewer number of men than the gas-driven station. It is evident, therefore, that the electrification

*Abstract of paper read before Fifth Midwest Power Engineering Conference, Chicago, Feb. 11, 1931.

of gas lines is a different problem from the electrification of oil lines and probably will proceed at a slower rate.

Gas-engine-driven compression units of today are essentially the same machines as manufactured for the past 30 years. The unit commonly used on the larger pipe lines has a horsepower rating of 1,000, and is built as a duplex-tandem, four-cylinder, double-acting engine driving duplex, single-stage compressor cylinders. Such an engine operates with a mean effective pressure as high as 70 lb. per square inch in the power cylinders. The bores of the cylinders are from 21 to 22 in., with 36-in. stroke, operating at 125 r.p.m., which gives a piston speed of 750 ft. per minute. Compressor cylinders generally are fitted with unloading valves to obtain variation in clearance to adapt them to a wider range of compression ratios and still maintain full load on the power end.

Station discharge pressure has been increased until in one important project now under way it will be 610 lb. per square inch. The pressure of the gas coming into the booster stations along the line generally does not fall below that which will produce a compression ratio greater than 2½ when recompressed. Ratios above this value result in too great power consumption for economical operation. Gas produced in a new field sometimes flows with a rock pressure as high as 2,000 lb. per square inch. But this seldom lasts for any great period of time, depending on the rate of production. In the case of old fields, the gas must be gathered by a vacuum system, adding greatly to the load of the initial compression station.

Gasoline Transportation

Widespread interest has been centered, during the past few years, on the revival of transporting refined oils through pipe lines over long distances. The history of this form of transportation dates back almost 40 years, when parallel 4- and 5-in. lines were laid in 1892 between Oil City, Pa., and Marcus Hook, Pa., a distance of 470 miles, to transport kerosene. Six pumping stations were used on the route, employing power pumps driven through gears by gas engines in the western stations, where gas was available, and steam engines in the eastern stations.

Recently, one of the large eastern seaboard refiners reversed the flow in its crude line extending from the Pittsburgh district and is making deliveries of gasoline. This operation is apparently successful. Pumping equipment consists of the steam pumps installed on the line many years ago. There are three other large gasoline pipe-line projects under way at this time, one in the East and two in the Middle West. Power drives of the pumps on these new lines represent three distinct forms, electric power, diesel engines, and gas engines using butane as fuel.

The eastern line will use motor-driven centrifugal pumps, two units operating in series to produce approximately 750 lb. pressure. The normal pressure coming to the suction will vary from 5 to 25 lb. per square inch, or probably higher in some stations, owing to the rugged nature of the terrain, causing locations where a single booster pump will operate on as high as 300 lb. suction pressure. The stations on this line have no surge tanks, the closed system minimizing evaporation losses.

The Great Lakes Pipe Line Company, in which six major Mid-Continent refineries are participating, is building a gasoline pipe-line system through the Middle West which will extend from Okmulgee northward to Kansas City, to Des Moines, with branches to Chicago and Minneapolis, which will total greater than 1,600 miles when completed.

Stand-By Equipment Considered Unnecessary

Pumping stations will be approximately 50 miles apart, the calculation being for 16 lb. pressure drop per mile, giving a station pressure of 800 lb. The stations will be equipped with surge tanks, but arrangements will be made so that a closed system can be used, the gasoline flowing into the pumps under approximately 15 lb. pressure. The pumping equipment will consist of horizontal, reciprocating, duplex, double-acting units driven through herringbone reduction gears by airless-injection full diesel engines. The engines are designed to burn fuel of low gravity, but the company expects to commence operations using 26 to 28 gravity gas oil, which will be shipped into the pumping stations by tank car. Jacket water will be cooled in cooling towers, make-up being supplied by the best available local sources. It is interesting to note that the reliability of pumping equipment is such that it has reached a stage where stand-by units are not considered necessary.

The second big gasoline pipe-line project in the Middle West, now under construction by the Phillips Pipe Line Company, is an 800-mi., 8-in. line from Borger, Texas, to St. Louis. Two engineering features departing radically from present-day pipe-line practices are high-speed centrifugal pumps, driven by gas engines through speed-increasing gears, and the use of butane gas as a fuel for the engines.

Pumping stations on this line will be approximately 100 miles apart. An 8-in. fire wall the full height of the building will separate the engines and the pumps. The stations will operate at a pressure of approximately 750 lb. by using two pumps in series.

A unique feature of this line is the fact that the operators intend to slug liquid butane through it for use in the engines of each station. A specific-gravity indicator will be used on the line at each station so that the operator can determine when his fuel is coming through the line and take off the amount that he requires for the next period of operation. When butane is being pumped station suction pressure will be maintained at from 80 to 100 pounds.

Butane is a recent newcomer in the commercial fuel field. A limited quantity of it is contained in motor gasoline and a certain amount in natural gas. Lately commercial uses were found for the gas by liquefying, storing and shipping it under pressure to domestic consumers. More recently, industrial markets have been developed for its use as a fuel. Because of its high B.t.u. content, which is approximately 3,200 per cubic foot, fuel consumption of liquid butane will spread over a long period. Before going to the engines it will pass through a mixing valve. The mixture will be approximately 30 parts of air to 1 part of butane gas. To keep the fuel in a liquid state it will be necessary to hold pressure on it constantly. For this purpose three storage tanks, having a size of 10x40 ft. and built for a working pressure of 80 lb., will be provided at each station.

In operation, this pipe line will handle four grades of refined products. Batch shipments will be made of cracked gasoline, gravity range of 55 to 58; straight-run gasoline, with a gravity of around 60; natural gasoline, with a gravity around 80; and butane of 114 gravity. The operation of these gasoline lines will be watched with considerable interest, since there will probably result a great saving based on present freight rates. There is nothing fundamentally unsound about the idea of transporting gasoline through pipe lines. Without question these lines are going to be successful and will be followed by the construction of new lines in the near future from other large refineries to centers of distribution.

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Water-Power Resources Of Quinault River

Total potential water power in the Quinault River Basin, Washington, as determined by the Geological Survey, United States Department of the Interior, amounts to 75,930 hp. for 50 per cent of the time and 25,950 hp. for 90 per cent of the time, if 60,400 acre-feet of storage is provided in Quinault Lake. This amount of storage could be obtained by a variation of 15 ft. in the lake level. Three power sites are available below Quinault Lake and two above the lake. The most serious objection to power development on the Quinault is possible interference with the free passage of salmon and other fish up and down the river.

These and other pertinent facts are set forth in a manuscript report prepared by Edward E. Jones, hydraulic engineer, which describes in detail the water-power resources of the Quinault River Basin. This report can be consulted at the branch office of the Geological Survey in the Federal Building, Tacoma, Wash., or at the main office in Washington, D. C.

Arc Welding In the Power Plant[1]

By W. H. ZORN

A brief sketch of welding as practiced at the Detroit Edison Company Plants

WELDING as a major tool with the Detroit Edison Company dates back to 1925. At this time the company possessed five or six electric welding units and perhaps twenty oxy-acetylene outfits. In 1929 the company had 60 electric welding units and 80 oxy-acetylene outfits. Five arc-welder operators in 1925 had increased to 100 in 1929. The acetylene units were used mostly for cutting. By using double shifts where necessary, 60 electric units took care of 100 welders.

The Pioneer Stages

When the second unit of the Trenton Channel plant was started in 1925 welding equipment was purchased and operators of proved ability hired. Building up worn shafting, the welding of piping, patching of uptakes and other similar work was attended with success, and the field began to broaden. Once the possibilities of arc welding were grasped by the foreman in charge of groups of mechanics a multitude of jobs began to come through. The next step was the complete welding of boiler uptakes, the first being completed at the Willis heating plant. Exactly similar installations of riveted construction in this plant gave an excellent opportunity for cost study. The replacement of heavy plates suitable for riveting and calking, by lighter plates for welding, and other savings in shop and field, made substantial savings.

A more extensive program for Delray Power House No. 3 was planned. New equipment was purchased and 45 operators were used in the Delray plant alone. One of the most economical applications in this plant was the substitution of arc-welded stairways and hand railings for riveted and bolted material. The stair flights are of standard lengths and are shop cut for erection. The hand railing, made from 1¼-in. pipe, is brought to the job in 20-ft. lengths, where it is marked by template, cut by the oxy-acetylene torch and arc welded in place. A substantial saving is made in this work. About 30,000 ft. of welded railing has been installed in this plant. Approximately 20,000 ft. of welded railing has been installed in other locations.

The plenum chambers, uptakes and economizer casings on five boilers in this plant are all welded and total thousands of feet of welding. Three water-storage tanks of 50,000 gal. capacity each and several smaller tanks were fabricated and installed by arc welding. Air ducts, coal-breaker housings, air washers are but a few of the many welded jobs done in this plant. Some 600 joints of pipe, in size of 3 to 24 in., carrying at highest pressure 125 lb., were arc welded. This piping includes general heating lines, vent lines, oil lines and compressor lines. As yet the operating departments are unwilling to permit the use of welding on high-pressure lines.

Welding Trucks

Three trucks equipped with complete arc-welding and acetylene units were purchased for use on small hurry-up jobs at outlying locations. The arc-welding unit in these trucks can be driven by either gasoline or electric power. With them five or six small jobs have been completed in a single working day. In comparing the cost of handling this type of work by these self-contained units with loading, trucking, unloading and wiring of the stationary unit, large savings are apparent and the unit pays for itself in a few months.

A large arc-welded job was a change from concrete construction to welded steel construction for oil switch cells. The first installation was 42 cells, weighing about eight tons each. Made in three compartments, they comprise the enormous amount of 20,000 linear feet of welding for this job alone. Fifty of these cells have been installed since the initial 42, and 97 more are being made now. Cells for the four substations total almost 100,000 ft. of welding. The use of steel plate and angles for partitions and suspended ceilings is another welding job of large proportions. Revisions and additions to existing structures have been simplified by the arc welding of new to the old structural steel. The placing of new ventilating systems in five substations called for the welding of 175 tons of plate steel. Five elevator shaft casings in size from 6 ft. square to 12x10 ft. and 120 ft. high were erected by tack welding, thereby making a light, smooth-finished job.

The conveyor bridge from the coal breaker house to the boiler house of Delray No. 3 is 350 ft. long, rising from the ground to an elevation of about 120 ft. Its two sides, of No. 0 gage plate arc welded dust-tight, contain over 4,000 linear feet of continuous welding.

In the Beecher Avenue machine shop and in the structural shop a large volume of welded material was being turned out during this period.

During 1930 three gondala-type coal cars that had seen much service were completely rebuilt by arc welding. They were stripped to the trucks and ten tons of steel plate, I-beams, channels and angles used in rebuilding them. Fifteen gondolas and dump cars were repaired at the same time, and the result was so satisfactory that five gondola cars are being completely rebuilt at the present, using 250 tons of steel and almost 50,000 linear feet of welding. They seem to stand the hard usage in the yards and coal tippers as well as the riveted-type cars.

Seventy-five Gas Outfits

Welding of the structural steel in the new coal ramp at the Connors Creek plant will be completed shortly. It involves the welding of 100 tons of structural steel. No rivets are being used. During this period of construction activity the repairs of broken parts and maintenance welding of all kinds are being carried on. Resurfacing of parts subject to wear, building up of shaftings, piping replacements and all the replacements necessary in the power house have contributed their quota to arc welding. The use of 75 oxy-acetylene outfits, mostly for cutting, brazing and cast-iron welding, completes the wide circle of welding equipment necessary in the modern power house.

Solving the Human Problem

The hardest problem to be faced in building up a competent welding organization is the selection of skilled operators. Once this problem has been met and solved most others will solve themselves. It is probably true that not enough time and money or study are spent on this all-important phase of arc welding. The selection of equipment, proper designing and the other factors depend, in the final analysis, on the man who deposits the weld. The Detroit Edison Company has been fortunate in being able to retain a nucleus of highly skilled welders. A few of these expert mechanics, available for work requiring skilled attention, are the backbone of the organization. It is surely a mistake to use Bill Jones or Sam Brown on a job requiring much skill when John Smith, an expert on that particular problem, is being used to weld two pieces of angle together. Know the ability of the man and keep him on work suited to that ability until he is competent to perform more skillfully and many welding problems will cease to be problems.

There is only one inspection for general welding and that is inspection during the actual operation. A good foreman or supervisor need not spend much time watching an operator weld after he knows the individual's ability. Impress the qualified welder with the rigidity of the welding requirements and he will give uniformly good welds. The foreman need but give his work a few minutes' inspection a day and successful welding will result. Couple these factors with laboratory checks and good, efficient production is assured.

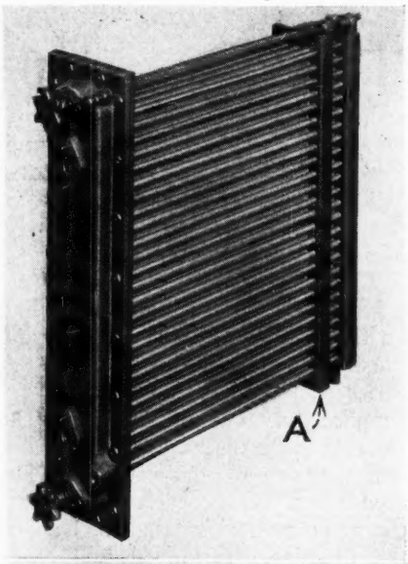
[1]Abstract of paper read before Midwest Power Engineering Conference, Chicago, Feb. 11, 1931.

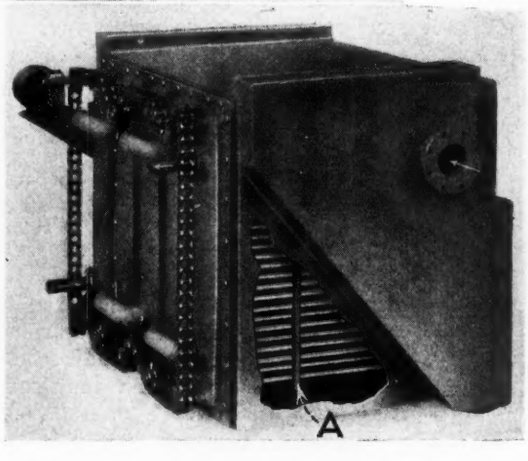
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Self-Cleaning Heat Reclaimer of Unit Construction

SIMULTANEOUS cleaning of the tubes in each section by means of power-propeller perforated plates characterizes the heat reclaimer recently developed by the Hoppes Manufacturing Company, Springfield, Ohio, for use in industries having hot waste water. A unit is made up from a number of sections (as shown in the upper view) in any size to suit customers' conditions and arranged to be extended by adding more units when desired.





View of individual section, showing arrangement of cleaning plate, and a complete unit of five sections

The cleaning is done by a perforated plate *A* in each section, as shown in the illustration. Each plate is mounted on two coarse-pitch screws by means of bronze nuts. The screws are revolved simultaneously by a reversible motor and chain drive and carry the perforated plates from one end of the tubes to the other and back. The openings in the plate are slightly larger than the tubes, to prevent scraping, but as the plates move forward and backward the water rushing through and around the tubes is said to give sufficient scrubbing action to thoroughly clean them.

To operate the cleaning device a double-throw switch is closed to move the plates from one end to the other of the bank of tubes. At the end of the travel one plate contacts with a collar on a rod running parallel with the tubes and stops the motor. The motor is then reversed by the switch and the plates brought back to the starting point.

The reclaimer is built with waterboxes of different sizes and length of tubes and in as many sections as required.

General Utility Floodlight

A 100-WATT general utility floodlight projector is announced by the General Electric Company, Schenectady, N. Y., for use where light requirements do not necessitate the larger standard floodlighting units. The projector, weighing less than 3 lb. and measuring less than 9 in. wide, 10 in. deep and 13 in. high with its supporting stand, is built for a standard 100-watt inside-frosted lamp.

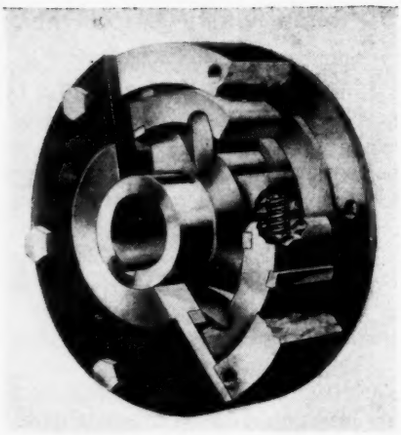
The new unit is composed of a sheet aluminum combination casing and reflector, pressed together with a separately drawn socket-supporting cap over a supporting ring. The front lens, 8 in. in diameter and of heat-resisting, clear, convex glass, is clamped against a gasket fitting in a groove in the reflector. A rubber-covered twin-conductor lamp cord is woven through a rubber bushing affixed to the socket-supporting cap to prevent entrance of moisture and abrasion of the cord. Vertical and horizontal adjustments are obtained with wing nuts in the swivel support and base.

100-watt floodlight projector

One-Way Positive Clutch

IN THE July 29, 1930, number the Pitter clutch, put out by the Universal Gear Corporation, 327 South La Salle St., Chicago, Ill., was illustrated and described. Since that time certain refinements have been made in the design of the clutch and an improved model is now being offered by the company.

Briefly, the clutch consists of a central forged-steel hub on either side of which are two hardened and ground steel races, a hardened and ground outer steel race, and three shoes. Light helical coil springs keep these shoes always in position for



Pitter one-way clutch

gripping, but the springs take no part in the drive. If the spindle is rotated in the driving direction the shoes lock against the inner and outer races, thus giving an instantaneous positive lock at two points on each of the three shoes, with no lost motion and no tendency to jam or slip.

Principal improvements made to the clutch are the changing of the springs from the free to the gripping end of the shoes and the insertion of alloy-steel contact members in the shoes at the two gripping edges. The whole clutch mechanism operates in oil.

Intended to replace ratchets, "no-backs," and over-running couplings, the clutch is particularly designed for converting alternating motion, either reciprocating or rotary, into one-way movement. Drive may be through either the outer ring or the hub at the center. The clutches range in size from ½- to 4-in. bore, and maximum torque ranges from 204 to 124,800 inch-pounds.

Bearing Clearance Compensator

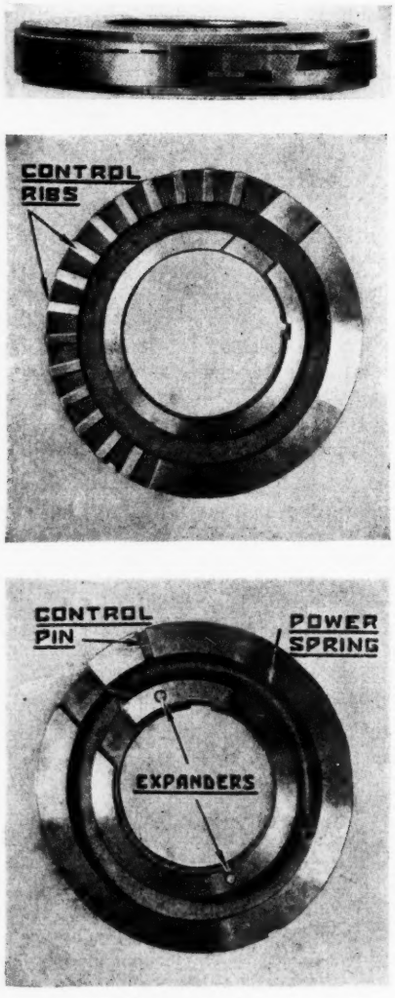
CONSTANT CLEARANCE in bearings is maintained automatically by the "Wyr-omat-ick" compensator announced by the Wyrick Engineering Company, Wyandotte, Mich. By taking up play in bearings as it occurs, this compensator prolongs the useful life of the bearing and of reciprocating parts. Necessity of machining to close limits is obviated, and lighter bearings may be employed in certain cases.

The major parts are two mating helical cam-faced members, which when placed together, as shown in the upper view, will increase or decrease their joint cross-sectional dimension if rotated in opposite directions. These two members serve the space-filling requirements which are necessary as wear occurs. The power spring shown in the lower view, which is attached to both cams when assembled, provides the power to rotate the cammed members whenever this action is required.

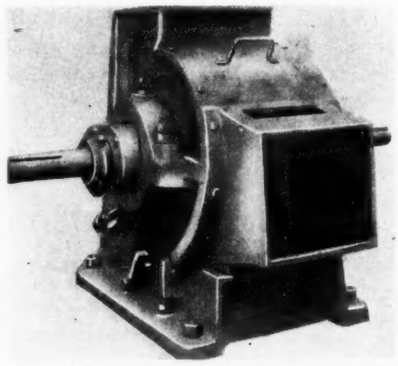
The expanders indicated are two hardened steel balls with expansion springs in back urging them outward to exert a pressure against the inner surface of the slotted cam when the cams are placed face to face. This action insures separation of the two cam faces as, through wear, increased space occurs.

The control pin shown is made to project beyond the face of the smooth cam a distance equal to the maximum clearance required. Then when the cams are placed together the pin projects into one of the slots and engages one of the ribs, insuring against any rotational action between the two cams until the maximum allowable amount of wear has taken place. The control ribs of the slotted cam are spaced to give the desired dimension of readjustment required at each adjustment period. For example, if the total cam rise is 0.062 and it is desired to readjust at each 0.001 increment of wear, then 31 ribs will be needed, equally spaced on one-half of the cam face, and the thickness of the cam would be 0.001 in. greater at each rib.

The principle of automatic adjustment is also embodied in designs suitable for use on connecting rod, sliding and other types of bearings.



Assembly and detail of cam-faced members



Type "A" hog with cast-steel cylinder and ball bearings

Medium-Sized Hog for Reducing Wood Waste

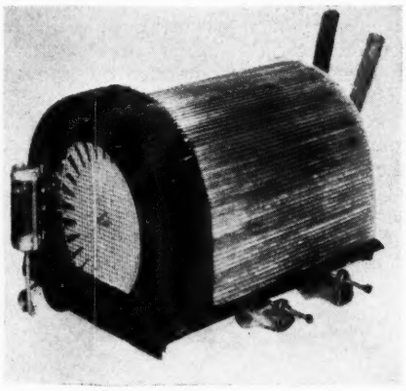
TO MEET the demand for a medium-sized machine capable of reducing all kinds of wood waste and other materials into a product ranging from a fine sawdust to a coarse fuel chip, type "A" hog, illustrated, has been developed by Mitts & Merrill, Saginaw, Mich.

The machine has a capacity of from 1,500 to 4,000 lb. an hour, depending on the character of the material and fineness to which it is reduced. A series of interchangeable screens are supplied, any one of which may be inserted in the discharge spout to control the size of the product. The feed spout is vertical and the discharge spout horizontal at the back of the machine. Equipped with cast-steel cylinder and roller bearing, the new machine embodies certain refinements not used heretofore in the larger units built by the same company. The shaft is arranged double-ended, so that drive can be from either side; it can be arranged with pulley for belt drive, flexible coupling for direct-connected drive or with grooved pulley for V-belts. The grinding element consists of four rotating knives and four stationary knives. The stationary knives are rectangular steel bars, all four corners of which may be used before regrinding is necessary.

Inclosure for Open-Frame Type Motors

ADAPTABLE to any open-frame motor to prevent accumulation of dust, dirt and moisture, the inclosure recently developed by the Daun-Walter Company, Milwaukee, Wis., is available for all open-frame motors, 2- and 3-phase, and direct-current motors in sizes from 5 to 100 horsepower.

The inclosure consists, essentially, of a specially designed corrugated copper cover over the motor, with steel end walls and supporting baseplate. At one end of the inclosure a cooling fan and an outside combination guard and air deflector are provided. The cooling fan is mounted on the end of the motor shaft opposite the pulley end by means of a special shaft adaptor. By means of the fan and the air deflector a single path of outside air discharges over

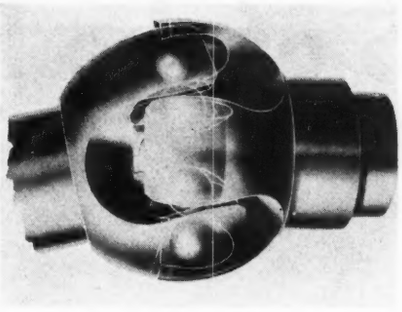


Inclosure in place over motor

the outside areas of the deep-fin corrugated copper construction over the motor, thereby carrying off the heat from the interior developed by the motor. The baseplate is of heavy-gage steel-box construction, and prevents the entrance of dirt, dust or moisture from below. The complete inclosure is designed to permit mounting on motor slide rails for belt adjustment. Provision is also made in the construction of the inclosure for ready inspection of the motor.

Universal Joint Gives Constant Angular Velocity

ALTHOUGH developed primarily for use in the automotive field, the universal joint put out by the Weiss Engineering Corporation, Grand Central Terminal Building, New York City, is adaptable to many



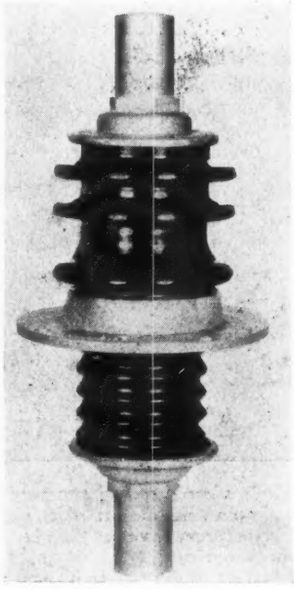
Universal joint designed to give constant angular velocity

types of equipment in the industrial field.

The outstanding feature of this joint is that it overcomes the angular velocity fluctuation common to most types of universal joints. The constant velocity factor depends upon maintaining the plane of driving engagement between the two yokes at half the shaft angle. This is accomplished by placing a number of steel balls, 4, 6, 8 or more, in intersecting races cut in the two joint members. The races guide the balls to one-half of the shaft angles from 0 to the designed maximum. Because of the rolling contact between the two members little lubrication is required. An oil-tight housing can be furnished.

High-Capacity Roof Bushing

A NEW LINE of high-current-capacity porcelain bushing-roof entrances is announced by the Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill. The bushing is compound-filled, and is said to be free from corona inside the porcelain, even when flashover potentials

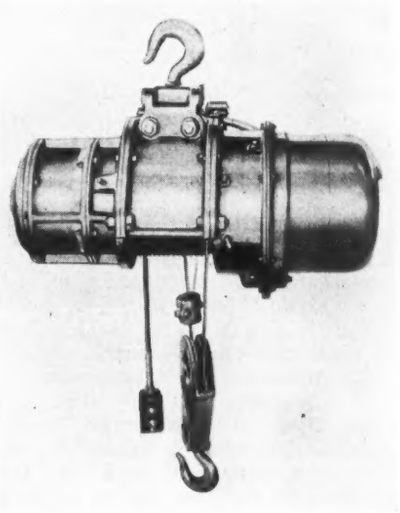


A 2,000-amp. roof bushing

are applied. It is of wet-process porcelain, with graded petticoats, improving the wet flashover ratios. Above the roof the dry flashover is 80 kv., wet 55 kv. The portion below the roof has a dry flashover of 55 kv. The terminals on either end are machined to standard pipe size.

Electric Industrial Hoists

DESIGNED for different types of suspension, and with either rope or pendant control, the new Wright hoist is available in capacities ranging



Type W hook-suspension hoist with push-button control

from 500 to 10,000 lb., and with hoisting speeds ranging from 70 to 12 feet per minute.

The hoists are equipped throughout with roller bearings, and with roller-bearing totally inclosed motors, either alternating-current or direct-current. Squirrel-cage induction motors are furnished for single-speed hoists, and slip-ring motors for variable-speed control.

Where push-button control is used the control switch carries only current for energizing the contactor. The control contactors for making and breaking the motor circuits are of the mechanical interlocking type. The variable-speed controller works in connection with a mechanically interlocked reversing contactor, the controller being of the face-plate type.

Other features include the use of safety limit switch, "Tru-Lag" performed-construction cable, large-sized drum and shrouded load blocks. The hoist is put out by the Wright Manufacturing Company, Bridgeport, Conn.

NEWS of the FIELD

Fuels, Piping Codes, Alloys, Corrosion, and Testing Discussed by A. S. T. M. Committees

Annual spring group meeting held at Pittsburgh on March 16-20 in conjunction with welding session

THE ANNUAL Spring Group Meeting of Committees of the American Society for Testing Materials was held at the Hotel William Penn in Pittsburgh, March 16 to 20, inclusive. In all, 23 committees of the society took part, with about 500 in attendance.

The group meeting was held in conjunction with the Pittsburgh regional meeting, comprising a symposium on welding, arranged under the joint auspices of the Pittsburgh section of the American Welding Society. The symposium consisted of two sessions, the morning session covering a general survey of welding, its history and applications, while the afternoon session discussed the inspection and testing of welding and welded products. A dinner was held in the evening followed by a demonstration of the analysis and synthesis of sound which was staged by the Westinghouse Laboratories.

One of the most important developments discussed by the Committee on Steel was the progress that has been made in the development of specifications for various types of fabricated pipe. Through the Subcommittee on Steel Tubing and Pipe there have now been prepared specifications for five different types of piping, namely, riveted pipe, lock-bar pipe, hammer welded pipe, electric resistance welded pipe, and electric fusion welded pipe. The substance of these specifications has now been agreed upon by the subcommittee, and after review by a harmonizing committee, it is expected that the specifications will be in suitable form for recommendation to the society for approval some time early in the summer. The Subcommittee on Valves, Fittings, Piping and Flanges for High-Temperature Service recommended a number of revisions in the Standard Specifications for Alloy-Steel Bolting Material for High-Temperature Service which will provide for bolting stock material as high as 7 in. in diameter.

Committee D-5 on Coal and Coke voted to advance to standard the present tentative method of test for size of anthracite. The only change to be made in the method is a more definite location of points of sampling.

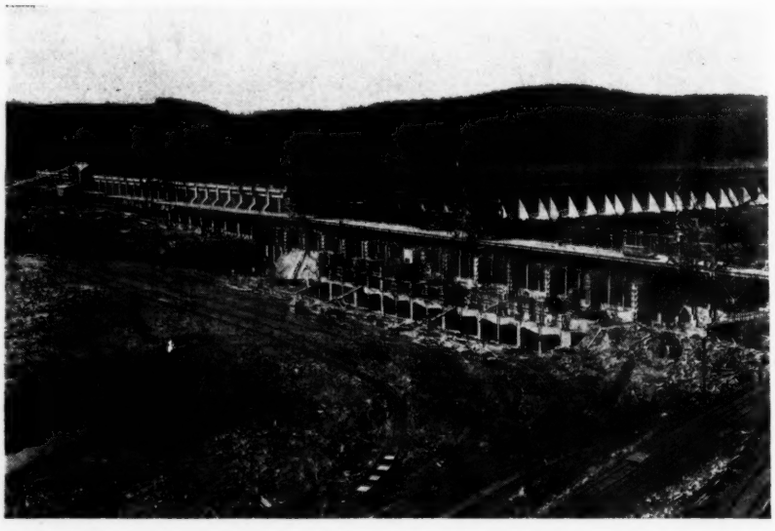
In cooperation with Committee D-2 on Petroleum Products and Lubricants and the Power Test Code Committee of the American Society of Mechanical Engineers, Committee D-5 will undertake the preparation of definitions of "gross calorific value" and "net calorific value" of fuels.

A proposed tentative method of sampling coke for analysis was presented for discussion. It will, however, not be recommended to the society as a tentative standard until it has been more thoroughly tested. Satisfactory progress was reported by various subcommittees on foundry coke specifications, sampling tolerances, sampling pulverized coal from unit pulverizers, and on the test for agglutinating value of coal. Progress was also reported in fuel oil specification work, in methods of test for color, distillation, gravity and for the evaluation of lubricating grease.

Committee A-10 on Iron-Chromium, Iron - Chromium - Nickel and Related Alloys discussed work undertaken in a standardization program of these alloy steels. It was determined to begin with the plain chromium steels. The subcommittee on Methods of Testing reported considerable progress on the comprehensive series of corrosion tests now underway in sixteen laboratories on studies of the DuPont acid-immersion test, the Navy Department salt-spray tests, and the copper-sulfate stain test. As the result of these investigations, the committee is expecting to prepare an inspection test for corrosion-resisting properties of alloy steels to insure uniform properties of different lots of material.

The research Committee on Fatigue of Metals decided to start the preparation of a statement of the present-day knowledge of the failure of metals under the simultaneous action of repeated loading and corrosion, which is a very serious problem; and to prepare a statement of the significance of results of "fatigue" tests under repeated loading for the structural engineer, the machine

SAFE HARBOR PROJECT PROGRESSING



Latest view showing progress of construction on the 510,000-hp. (ultimate) hydro-electric project of the Safe Harbor Water Power Corporation, on the Susquehanna River at Safe Harbor, Pa. Draft tubes have already been poured for seven of the 42,500-hp. main units and two station service units to be installed in the power house shown in the foreground, although only six main units are included in the initial development of 255,000 horsepower

designer, and the makers and users of boilers and other pressure vessels.

The Subcommittee on Impact Testing reported that it plans to include in its annual report translations and abstracts of a number of articles dealing with impact testing. A review is being made of the present state of knowledge concerning the impact test, with particular reference to those applications where the impact test has been of value. A statement will then be prepared covering the points concerning each. Further research was urged looking toward the possibility of undertaking a comprehensive research investigation on the test.

Bids Opened for National Hydraulic Laboratory

SIXTEEN BASIC BIDS were received on March 23 by the United States Bureau of Standards for the construction of its new National Hydraulic Laboratory. The low bidder for the job is the firm of Stofflet & Tillotson, which submitted a bid of $303,900. Other bidders and the amounts submitted range in the following order: George E. Wyne, $305,400; Arthur L. Smith Company, $313,700; Lee Paschall, $317,000; Laundoun-Rust Company, $319,445; Charles H. Tompkins, $321,850; Skinker & Garrett, $323,878; National Construction Company, $324,900; M. Shapiro & Son, $327,000; Maitico Construction Company, $327,966; Turner Construction Company, $331,000; George Hyman Construction Company, $345,000; W. P. Thurston, $348,000; Boyle-Robertson, $349,500; P. C. Street, $356,000; and Bahen & Wright, $358,982.

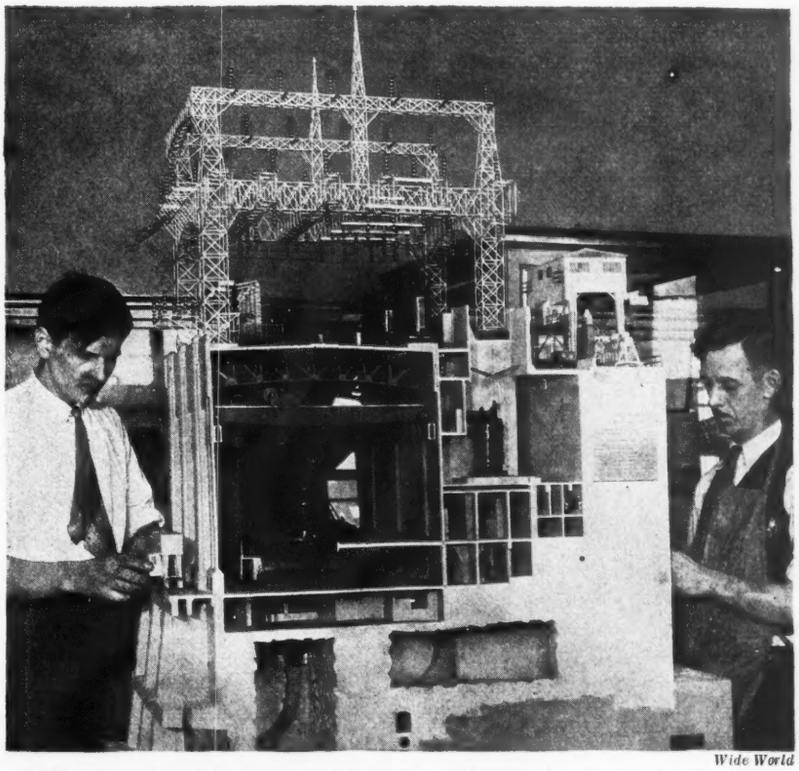
New York Senator Predicts Passage of St. Lawrence Bill

WARREN T. THAYER, chairman of the Senate Committee on Public Service said March 25, in an exclusive interview, that the Legislature would pass the Cornaire bill providing for the creation of a power authority to build the St. Lawrence River project, with possibly some slight amendments; that the bill would probably not be independently introduced in the Senate; and that he did not think a public hearing would be held thereon. He said it was not the disposition of the Senate to accept the recommendation of the Governor for the appointment of three commissioners at $20,000 a year salary in lieu of the part time members of the power authority provided in the bill.

Senator Thayer said that the bill passed by the legislature this year would enable the State of New York to officially start negotiations and that amendments could be made next year as practical experience of the authority might determine.

The Senator is convinced in his own mind that the United States government will eventually build the dam and allow the State of New York or some other agency to make the actual development of the hydro-electric power. The Senator stated that negotiations have been pending between federal government officials and Canada for some weeks now and that President Hoover after his return from his vacation is due to make an announcement of the result thereof.

SMITHSONIAN GETS CONOWINGO MODEL



Wide World

This sectional model of the 378,000-hp. Conowingo hydro-electric development on the Susquehanna River in Maryland, showing every detail to scale, was recently presented to the Smithsonian Institution by the Philadelphia Electric Company

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Mining Company Completes Steam Plant in Michigan

A NEW AUXILIARY STEAM PLANT is now in operation at the Ahmeek stamp mill of Calumet & Hecla Consolidated, near Lake Linden, Mich. Constructed at a cost of approximately $1,500,000, the plant consists of a power house and boiler installation with a capacity of 180,000 lb. of steam per hour. The boiler supplies steam for both the stamp mill and turbines, which have a total output of 11,000 kilowatts.

Modern in every respect, the new plant is supplementary to the mining company's main power station at Lake Linden, which has a capacity of 17,000 kw., and two smaller plants at the Ahmeek mill and a smelter at Hubbell. Ample power, generated at the lowest possible cost, is now provided by the combined plants for all future operations of the company.

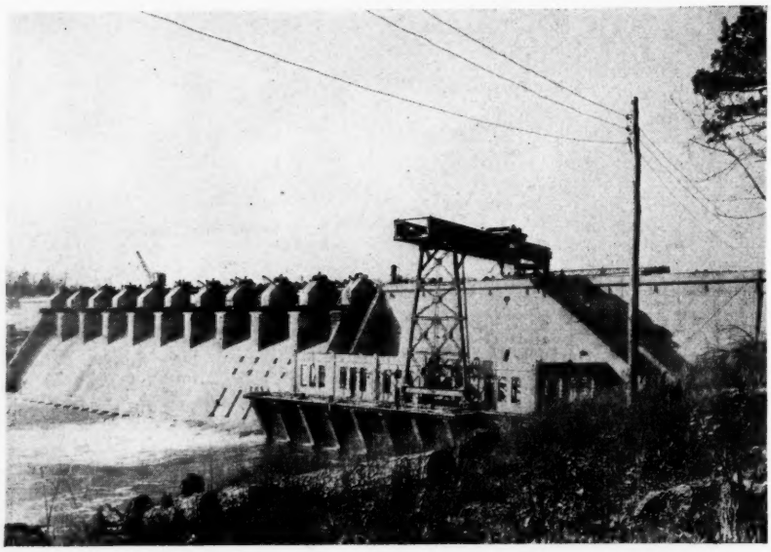
Georgia Power Seeks to End Rate War in Crisp County

SEEKING TO END the rate war between the Georgia Power Company and the Crisp County-owned hydro-electric plant, President Preston S. Arkwright of the company appeared before the Georgia Public Service Commission on March 25 and asked permission to raise the company's rates in Crisp County 35 per cent to the level of the county plant.

Mr. Arkwright testified that before the county plant was in operation the power company had 1,100 customers in the area with gross annual revenue of $81,000, while today the company has only 125 customers with an annual gross revenue of $5,691. He added that the company pays the county and the city of Cordele, near which the county project is located, $6,316 a year in taxes.

The county-owned plant—said to be the only county-owned hydro-electric project in the country—was completed last year after local residents maintained the power company rates were too high. The new plant started operation with a 25 per cent reduction from the company rates, and the company soon cut its rate to 35 per cent below the county rate. The public service commission then issued an order asking the power company to show cause why this rate should not prevail throughout the State.

CARPENTER DAM NEARS COMPLETION



With an initial capacity of 79,000 hp., the Carpenter Dam plant of the Arkansas Power & Light Company, on the Ouachita River, is rapidly nearing completion. The initial installation consists of two 39,500-hp. francis turbines operating at 94.7 r.p.m. under a head of 89 feet

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Cleveland Studies Plans For Enlarging Power Plant

SEVERAL PLANS for enlarging the municipal power system of Cleveland are now under consideration by the Department of Public Utilities, according to a report just issued by the Division of Light and Power, which operates the city plant. The report states that the plant at present is loaded to capacity, carrying at times a peak load of 53,000 kw. when the maximum safe load with the largest generator out is only 38,000 kw. More load could be secured if the plant were able to take care of it, and various proposals are made in the report for enlarging the system to handle this new business.

The report presents details of the growth and development of the system since its establishment in 1915 to the end of 1930. During that time the installed capacity of the steam station has increased from 15,000 to 50,000 kw., substation capacity from 18,000 to 48,900 kw., miles of high-tension transmission lines from 39 to 111.1, miles of distribution cable from 571.5 to 3,534.4, the kilowatt-hours sold annually from 25,800,000 to a maximum of 156,600,000, the load factor from 46.3 to 59.1 maximum, and the total investment from $3,237,000 to $15,300,000. At the same time the coal required to generate a kilowatt-hour has decreased from an average of 2.33 lb. for the first three years to 1.88 lb. for the last three years.

Through the competition it offers, the municipal system has forced the local privately owned utility to maintain rates well below the average of those paid in other cities of the country. "Had the citizens of greater Cleveland paid the prevailing rates throughout the United States, instead of the very low rates which have been in effect for the past fifteen years, due in main to the competition of the municipal light plant, the additional cost to the people of greater Cleveland would be, roughly estimated, on the order of $39,000,000," the report says.

Starting with its first year of operation, the system has had money left in the treasury after paying all operation, maintenance, and fixed charges. For the past nine years there has been a surplus after making deductions to the deferred upkeep reserve and paying all other charges except taxes. With deductions made for estimated taxes, a surplus was earned in seven out of the fifteen years of operation.

Alabama Governor Seeks Muscle Shoals Conference

IN ACCORDANCE with the suggestion contained in President Hoover's recent veto message on the Norris Muscle Shoals bill, Governor B. M. Miller announced on March 21 that he will present to the State Legislature when it reconvenes on March 31 a proposal that a commission be named to confer with a similar commission from Tennessee and with representatives of the National Farm Bureau and the Engineer Corps of the Army in an effort to solve the Muscle Shoals problem.

"I believe," said Governor Miller, "that it is a probability that these two commissions, in cooperation with the farming interests of the nation and in cooperation with the government engineers, can work out a solution of this knotty problem of what to do with the Muscle Shoals. If a solution can be found, and I believe it will, a great public service will have been done and the long wrangling over Muscle Shoals will come to an end."

South Carolina Hydro Tax Killed; New Bill Introduced

BY A VOTE of 43 to 40 the South Carolina House killed last week a bill providing for a tax of one-half cent per kilowatt-hour on all hydro-electric power generated within the state. (See *Power* for March 3, p. 386.) A few days later the ways and means committee of the House introduced another hydro-power tax bill, proposing a levy of three-tenths of a mill per kilowatt-hour. The new measure is similar in every respect to the defeated bill except for the rate of tax.

Plan 42,000-Kw. Hydro-Electric Plant in Japan

CONSTRUCTION of a 42,000-kw. hydro-electric plant on the Tenryu River, Japan, is being planned by the Daido Electric Power Company, at a cost of 12,000,000 yen, according to report of *Denkinotomo,* a Japanese publication. The report speculates on the situation which will result when the project is completed and the power is ready for transmission. If it is transmitted to Tokyo it will bring additional power to an already over-supplied district and probably cause the Tokyo Electric Light Company some concern, while if it is transmitted to Nagoya, it will conflict with the interests of the Toho Power Company.

230-Mile Gas Line to Serve Butte and Anaconda, Mont.

CONTRACTS have been signed by the Anaconda Copper Mining Company and the Montana Power Company with Louis B. O'Neil for the delivery of 10,000,000,000 ft. of natural gas in Butte, Anaconda, and other cities of the state. The gas will be piped from the Cutbank area in northern Montana to Butte with branch pipe lines to take care of neighboring cities. The main pipe line will be 230 miles long. It will be not less than 20 in. in diameter and will require between 800 and 1,000 carloads of pipe. In order that a proper working pressure is maintained, compressor stations will be erected along the pipe line, which will maintain a minimum pressure of 765 lb. to the square inch. The total expenditure for this project will be between ten and twelve million dollars.

A. W. Leonard Goes With Engineers' Public Service

ACCORDING TO ADVICES received in Seattle, Wash., from New York, and confirmed at the offices of the Puget Sound Power & Light Company in Seattle, A. W. Leonard, president of that company since 1914, will retire on April 1, to assume chairmanship of the parent company, Engineers' Public Service Company, of New York. He will succeed C. W. Kellogg, who is retiring. Mr. Leonard's position in Seattle will be filled by J. F. McLaughlin, vice-president of the Eastern Texas Electric Company and of the Gulf States Utilities Company.

A. W. Leonard

Simultaneous with this announcement is the statement that the Engineers' Public Service Company will on May 1 assume control of the Puget Sound company. A contract under which the Stone & Webster Service Corporation had operated all the Engineers' Public Service utilities having ended, the parent company will now, it is stated, itself operate its properties.

World Business Conference In Washington, May 4-9

BUSINESS MEN from the 46 countries represented in the International Chamber of Commerce will meet in Washington, D. C., on May 4 to 9, to attend the sixth annual world business conference, sponsored by that organization. A major feature of the conference will be a discussion of the causes of the present international trade depression and the possible remedies for it. In keeping with this, tariffs, embargoes, cartels, quotas, war debts, and Soviet Russia's marketing practices will be discussed with the utmost frankness.

This will be the first meeting of the International chamber in the United States, and it promises to be a notable one. A larger attendance than at any previous annual meeting is expected. Large and representative delegations will be in attendance from the countries which have important commercial relationships with the United States. Every delegate will be encouraged to express his real feelings on the highly controverted matters which will be considered. The object is to build up a record of the best thought on these subjects in the hope that it may lead to action.

No other feature of the meeting is expected to excite more interest than the discussions of the attitude business should take toward various activities of Soviet Russia.

American Firm Formed to Acquire European Utilities

THE EUROPEAN GAS & ELECTRIC COMPANY has been incorporated under Delaware laws with a capitalization of 1,250,000 common shares to acquire interests in European public utility companies and projects, it was announced March 21. Officers of the new company include Henry J. Pierce, president, who was for several years president of subsidiaries of the American Power & Light Company, and Robert D. McCarter, a vice-president, who has given up his consulting engineering practice which included the construction and management of plants in many foreign countries, to devote his entire time to the company. Other officers are: vice-presidents, H. G. Scott, president of the Memphis Natural Gas Company, and Stuyvesant Le Roy, attorney; treasurer, Hugh R. Johnston, president of the Sterling Securities Corporation; and secretary, W. K. Petigrue.

Navy Orders Eight More Welded Boiler Drums

EIGHT MORE BOILERS with electric welded drums have been ordered by the Bureau of Engineering of the United States Navy Department from the Babcock & Wilcox Company for use on the new 10,000-ton cruisers, which are now under construction. These are in addition to 24 boilers ordered last fall from the company for the same type of cruisers, which marked the initial use of welding on main boiler drums by the Navy Department.

The first electric welding to be undertaken by the Navy Department was for the superheater drums for the light cruiser Portland. This welding work was let under a subcontract by the Bethlehem Ship Building Corporation to the A. O. Smith Company of Milwaukee. The Portland will be completed in 1932.

Approximately 48 in. in diameter, the drums are designed for 300 lb. pressure and 150 deg. F. superheat. The total cost of the 32 boilers is estimated at $700,000, and under the terms of the contract; the boilers are to be delivered from time to time to the various navy yards in a knock-down condition.

Reed Made Vice-President of Westinghouse Elevator Co.

AT A MEETING of the board of directors of the Westinghouse Electric Elevator Company held in New York on March 26, Frank C. Reed, general sales manager of the company, was elected vice-president in place of R. I. Phillips, who has resigned.

Mr. Reed was born in Mercer County, Pa., in 1879. He attended the Massachusetts Institute of Technology, and immediately after graduating in 1903, he entered the apprenticeship school of the Westinghouse Electric & Manufacturing Company, and has been associated with this organization ever since.

Frank C. Reed

He remained at the company's headquarters at East Pittsburgh until 1921, being first in the price department and later in the industrial sales department, and was then appointed manager of the company's Huntington, W. Va., office. This position he held until 1927 when he was made general sales manager of the Westinghouse Electric Elevator Company, with headquarters at Chicago.

Seattle Council Rejects New Nominee for Ross' Job

REAFFIRMING ITS DETERMINATION to approve no nomination for superintendent of the city lighting department except that of former Superintendent J. D. Ross, the Seattle City Council on March 23 rejected Major W. Chester Morse, Mayor Edwards' second nominee. The Mayor is expected to submit the name of Armand F. Marion, his original choice, next week, alternating the two names at ten-day intervals.

Mayor Edwards filed fifteen more charges against Mr. Ross, going back twenty years for his material, and Mr. Ross branded each charge as false, being backed up by several councilmen who said that the charges were "old stuff." The Council is expected to invite the Mayor to appear and substantiate his accusations.

Obituary

J. L. STANNARD, chief engineer of the Tacoma, Wash., Department of Public Utilities, died in Glendale, Calif., on March 13, after an illness of less than a month. Mr. Stannard was known as the "father" of the Cushman power project under construction by the city of Tacoma, of which the second unit is rapidly nearing completion. He was born at Chittenango, N. Y., on Sept. 15, 1866, and graduated from Cornell University. Before he came to Tacoma in 1923 he had been employed in important irrigation, water-works, and power-plant developments on the Pacific Coast, including projects constructed by the Grant Smith Company in California; the Cedar River power plant of the city of Seattle, and the Bull Run water system of Portland. He was consulting engineer for the North Coast Power Company in Portland from 1912 to 1919. Before assuming charge of the Cushman power project, he had been employed to make private reports on the project. At the time of his death, he was serving his second term as president of the Tacoma Section of the American Society of Civil Engineers, which he had been instrumental in forming.

JOHN G. GUSTAFSON, a mechanical engineer employed by the Otis Elevator Company and the inventor of many devices used on elevator doors, died on March 21 of heart disease in his home at Teaneck, N. J. He was 38 years old. Mr. Gustafson perfected a number of devices which increased the safety of elevator operation. He was born in New York City. Following his graduation from New York University he began engineering research work. He was a member of the American Society of Mechanical Engineers and the Swedish-Norwegian Society of New York.

LOUIS METESSER, power plant construction engineer and inventor of an automatic underfeed stoker, died on Feb. 26. Mr. Metesser was widely known for his engineering projects throughout the Southern States and Cuba, where he was a construction engineer on power developments for the Cuban Sugar Mills. He also held numerous stoker patents, including one for the "Universal" automatic underfeed stoker, which he produced prior to his retirement from active business.

HENRY CLAY GRATON, 100, one of the oldest industrialists in the United States and founder of the Graton & Knight Company, Worcester, Mass., in 1851, died March 20 there. He had retired ten years ago.

ALFRED BISHTON BOTFIELD, 83, originator of high-temperature cement and founder of that industry in the United States, died recently in Miami, Fla. Mr. Botfield established the Botfield Furnace Specialties Company, in Philadelphia, which has now become the Botfield Refractories Company, under the presidency of his son.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Hotel President, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

JOHN R. FREEMAN, internationally known hydraulic engineer who was recently on the advisory staff of the National Hydraulic Laboratory at the United States Bureau of Standards, has been elected a member of the scientific advisory board of the great outdoor laboratory of the Forschungs-Institute der Wasserbau near Munich, Germany, along with Professor SEIFERT, director of the Prussian Research Institute for Hydraulics at Berlin.

DR. WILLIS R. WHITNEY, director of the research laboratory of the General Electric Company at Schenectady, N. Y., has been awarded the Franklin Medal for 1931. Presentation of the medal will be made at the Franklin Institute's medal day exercises on May 20 in Philadelphia.

CARL M. GILT, formerly inside plant engineer of the Brooklyn Edison Company, has been appointed outside plant engineer to succeed WALLACE B. KIRKE, who resigned because of ill health. As head of the inside plant bureau since 1926, Mr. Gilt played an important part in the design of the Hudson Avenue generating station.

JOHN A. MAIR, foreman of the two-cycle diesel engine section of the Worthington Pump & Machinery Corporation's Buffalo works, has been promoted to the newly created position of field engineer. His new duties will include periodic visits to plants where Worthington engines are in use or are being installed, to demonstrate correct operation of the units.

B. L. EDDY and E. F. SLADE have been appointed by Governor Meier of Oregon to serve without compensation as members of the newly created state hydro-electric commission. Mr. Eddy is a member of the state senate and an attorney, while Mr. Slade is president of the First National Bank of Salem. C. E. STRICKLIN, state engineer, is the third member of the commission, which, as reported last week in *Power*, will pass on all applications for appropriation of water from Oregon streams for power purposes.

JULIUS MULLER, formerly with the Henry Vogt Machine Company, is now development engineer for the Leeds & Northrup Company of Philadelphia.

J. B. MACNEILL, formerly manager of the circuit-breaker engineering department of the Westinghouse Electric & Manufacturing Compay, has been made general manager of distribution engineering with headquarters at East Pittsburgh.

HOWARD M. NAYLOR, construction engineer with the Kansas Power & Light Company, has been appointed Topeka district manager of the company to succeed GEORGE H. ALBORN, who has assumed new duties in Atchison.

Business Notes

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, announces the opening of a direct factory branch office at 602 Esperson Building, Houston, Texas. Thomas P. Burke has been appointed district manager in charge of sales at the new office, it is stated.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., announces the appointment of Bell & Eiss, Inc., 459 N. W. National Life Building, Minneapolis, Minn., as its representatives in that territory.

CONCO CRANE & ENGINEERING WORKS, division of H. D. CONKEY & COMPANY, Mendota, Ill., announces the appointment of two new sales representatives, as follows: C. P. Maxon, Auditorium Garage Building, Cleveland, Ohio, and Starr-Carpenter, Parks Building, Pittsburgh, Pa.

IONIC ENGINEERING COMPANY, Cleveland, Ohio, with general offices in the Union Trust Building, has been appointed sales organization for the marketing of the Ionic electric water softener, manufactured by the Shomer Company, also of Cleveland.

M. H. DETRICK COMPANY, Chicago, Ill., announces the transfer of F. I. Sheahan from the position of chief engineer of the company at Chicago to San Francisco as Pacific Coast manager. C. F. Pollen, formerly in charge of the Pacific Coast office, has been returned to Chicago as sales engineer.

How's Business?

"JUST AS EIGHTEEN MONTHS of depression bring good business times nearer, so I believe the recent hard years in the diesel engine industry in the United States bring us closer to a greater utilization of the diesel, both for stationary and marine purposes.

"We received an order this month from the Public Service Company of Colorado for a 3,000-hp. diesel generating unit to be installed at Sterling. Besides this unit, we now have the following stationary engines on order: one 4,000-hp. for Tucson, Ariz.; one 3,000-hp. for Freeport, N. Y.; one 1,000-hp. for Opelousas, La. I believe this shows a trend toward larger sizes which will quickly yield the necessary volume of business for profitable operations.

"I am optimistic that within another year we will be out of the woods and that a very bright future lies before the entire diesel engine industry in the fields of stationary power plants and transportation, both on land and water."—EDWARD B. POLLISTER, president of Busch-Sulzer Bros.—Diesel Engine Company.

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WITH THE SOCIETY SECTIONS

A.S.M.E., Anthracite-Lehigh Valley Section. Meeting and exhibition at the Hotel Altamont, Hazelton, Pa., on Saturday afternoon and evening, April 18. General subject: "Practical Industrial Lubrication." A large number of manufacturers are expected to exhibit small lubricating devices and equipment. Manager, C. W. Bell, 177 East Broad St., Hazleton, Pa.

A.S.M.E., Metropolitan Section. Meeting in the Engineering Societies Building on April 29 at 8 p.m. Subject: "Developments of the Stationary Diesel Engine Under the Conditions of American Power Economics," by Julius Kuttner, editor of *Diesel Power*.

A.S.M.E., Ontario Section. Joint meeting with the Hamilton and Niagara Branches of E.I.C. and the Buffalo Section, A.S.M.E., in Hamilton, Ont., on April 2 at 2 p.m. Plant inspection trips in the afternoon followed by dinner and address in the evening. Subject: "Steam Storage," by J. P. Wys, Ruths Steam Storage Limited.

N.A.P.E., New England Association. Annual convention at Worcester, Mass., June 18-20. Secretary, W. B. Powers, 498 Green St., Cambridge, Mass.

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Trade Catalogs

REGULATORS—Information on "A-Jacks" control for high-pressure boilers is contained in an illustrated bulletin recently issued by the National Regulator Company, 2301 Knox Ave., Chicago, Ill. Among the equipment described are a steam-damped regulator, over-fire control, and cam valves. Full details on the operation and installation of these products is given.

INSTRUMENTS—Catalog No. 406, recently published by the Esterline-Angus Company, Indianapolis, Ind., describes in detail the construction, operation, and application of the full line of graphic electrical instruments manufactured by the company. Many illustrations and detailed specifications of the meters are included in the publication.

BLOWERS—The Roots-Connersville-Wilbraham division of the Stacey Engineering Company, Connersville, Ind., has just issued two new bulletins, 21-B10 and 21-B11, covering a new line of Victor-Acme blowers with a wide range of capacities. These bulletins replace both bulletin 121 formerly issued on Victor blowers by the Connersville Blower Company and bulletin 21-B2 on Acme blowers by the P.H.&F.M. Roots Company.

DIFFERENTIAL PRESSURE CONTROL—A comprehensive discussion of the subject of differential pressure control in the boiler feed line is contained in a new booklet issued by the Northern Equipment Company, Erie, Pa. Attractively illustrated in color, this publication also contains descriptions of Copes Type SS differential valve and Type RG combined regulator.

ELECTRONIC CONTROL—Instruments, relays, and electronic devices are described and illustrated in a 136-page catalog, No. 211, recently issued by the Westinghouse Electric & Manufacturing Company, Newark, N. J. Covered in this catalog are photo-electric tubes, grid-glow tubes, light relays, ammeters, voltmeters, frequency instruments, galvanometers, power factor meters, tachometers, and wattmeters.

WIRE PRODUCTS—A pocket-size booklet showing a list of the products of the American Chain Company, Bridgeport, Conn., and associated companies has just been issued. Among the equipment listed are chains, wire rope, cable, steel wire, springs, etc.

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Fuel Prices

FUEL OIL

Boston—March 23, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.95c. per gal.

New York—March 26, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots 6c. per gal.

Philadelphia—March 23, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—March 11, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Cincinnati—March 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—March 20, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 50c. per bbl.; 22@24 deg., 55c. per bbl.; 24@26 deg., 60c. per bbl.; 26@28 deg., 70c. per bbl.; 28@30 deg., 80c. per bbl.

St Louis—March 19, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg., $1.620 per bbl.; 32@36 deg., gas oil, 3.526c. per gal.; 38@40 deg., distillate, 4.151c. per gal.

Dallas—March 21, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.00
Smokeless, slack	Chicago	1.00 @ 1.35
Harlan, Ky., slack	Chicago	.80 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.85 @ 1.35
W. Ky., slack	Louisville	.75 @ .85
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	1.00 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.75 @ 1.15
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Tuscaloosa — U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until April 21 for the construction of a group of buildings including refrigerating and ice-making plant, boiler plant, etc. at U. S. Veterans' Hospital here.

Calif., Anaheim—Anaheim Orange Association, c/o H. A. Hamm, 2145 Sacramento St., Los Angeles, Archt., is having plans prepared for the construction of a pre-cooling plant here. Estimated cost $70,000.

Calif., Brawley—City is having estimates and reports made for power plant improvements. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., are engineers.

Calif., Burbank—City, F. S. Webster, Clk., is receiving bids for the construction of a 20 x 80 ft. sub-station.

Calif., San Francisco—University of Standford, Palo Alto, plans the construction of a medical school and hospital at Sacramento and Webster Sts. here. Estimated cost $2,500,000.

Conn., New London — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will soon award contract for the construction of a Diesel engine laboratory building at Submarine Base here. Estimated cost to exceed $40,000. Private plans.

D. C., Washington—M. J. Uline, 1150 Third St. N.E., awarded contract for the construction of an ice manufacturing plant to Consolidated Engineering Co., 20 East Franklin St., Baltimore, Md. Estimated cost $35,000.

Ind., Anderson—Indiana R.R., c/o H. Bucher, V. Pres. and Gen. Mgr., Traction Terminal Bldg., Indianapolis, plans the construction of four electric power sub-stations complete with new high tension lines. Estimated cost $40,000. Owner is in the market for copper wire.

Ind., Shelbyville—C. C. Shipp, had plans prepared for the construction of a power plant on Flat Rock River, nine mi. from Shelbyville to include dam, 238 ft. long and 20 ft. high, retaining wall, 850 ft. and spillway, 147 ft. Estimated cost $175,000. Schaeffer & Gift, Indianapolis, are engineers.

Ia., Dallas Center—City plans an election April 16 to vote $66,000 bonds for waterworks improvements including wells on Raccoon River, pumping equipment, tank on tower, etc. W. E. Buell Engineering Co., Sioux City, is engineer.

Kan., Kansas City—Bd. of Public Utilities, C. A. Lowder, Secy., awarded contract for furnishing and installing pumps in connection with 94 x 130 ft. power plant to De Laval Steam Turbine Co., 432 Dwight Bldg., Kansas City, Mo. $10,870.

Me., Biddeford—Cumberland County Power & Light Co., G. E. Haggas, Ch. Engr., 443 Congress St., plans the construction of a power plant including transmission lines on Saco River. Estimated cost $300,000. Private plans.

Mass., Boston—Hospital Dept., awarded contract for the construction of an electrical distribution center at City Hospital to M. Cummings Co., 43 Tremont St. Estimated cost $86,000.

Mass., Gardner — Dept. of Mental Diseases, Boston, is having plans prepared for the construction of a power generating plant including turbines, stokers and switchboard at Gardner State Hospital here. Estimated cost $80,000. A. B. Franklin Inc., 25 Haverhill St., Boston, are engineers.

Mass., Reading—Electric Light Dept., 177 Main St., is having preliminary plans prepared for a switch house. Estimated cost $30,000. Private plans.

Mass., Springfield — Commanding Officer, Springfield Armory, will receive bids until April 21 for replacement of steam boiler plant at Hill Shops, Springfield Armory.

Mich., Detroit—Dept. of Water Supply, awarded contract for addition to East Side pumping at Waterworks Park to Brow-Stanley Co., 2411 14th St., $15,975.

Minn., Duluth—Bd. of Education, R. J. Coole, plans the construction of a central heating plant for Central high school, Washington, junior high school, administration building and Liberty elementary school at Lake Ave. between Second and Third Sts. Estimated cost $82,000. Bids for boilers, stokers and chimney stack will be opened April 2.

Mont., Great Falls—City will receive bids until April 3 for waterworks improvements including pumping plant, etc. Estimated cost $225,000. C. P. Wells is city engineer, Black & Veatch, Mutual Bldg., Kansas City, Mo., are consulting engineers.

Mo., Caruthersville—City, defeated $90,000 bond election for the construction of a power and light plant, generating equipment and distribution system. Russel & Axon, 6200 Easton Ave., St. Louis, are engineers. Will call a new election at an early date.

Mo., St. Louis—Frank Building Corp., c/o Manhattan Dearborn Corp., 231 South La Salle St., is having preliminary plans prepared for the construction of a 29 story office building at 12th Blvd. Olive to Pine Sts. Estimated cost $2,500,000. P. J. Bradshaw, 718 Locust St., is architect.

N. J., Holmdel—Dept. of Institutions & Agencies, W. Ellis, Comr., State Office Bldg., Trenton, will soon award contract for the construction of a reception and treatment hospital including steam heating and ventilation systems, boilers, elevators, etc., at New Jersey State Hospital here. Estimated cost $1,000,000. Division of Architecture & Construction, State Office Bldg., is architect and engineer.

N. Y., Brooklyn—Dept. of Hospitals, Municipal Bldg., will receive bids about July 1 for the construction of an admitting and emergency building, also refrigeration plant at Coney Island Hospital here. G. McCabe, 96 5th Ave., is architect.

N. Y., Canandaigua—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until April 14 for the construction of a group of buildings including refrigerating and ice-making plant, boiler plant, etc. at U. S. Veterans' Hospital here.

N. Y., Dongan Hills (mail Staten Island)— Dept. of Hospitals, Municipal Bldg., New York, will receive bids about Aug. 1 for the construction of a power house and heating system at Sea View Hospital here. Sibley & Fetherston, 205 East 42nd St., New York, are engineers.

N. Y., New York—Corp., c/o Lefcourt Construction Co.., subsidiary of A. E. Lefcourt Realty Holding Co., 295 Madison Ave., plans the construction of a 45 story office building on Wall St. Estimated cost between $5,000,000 and $6,000,000.

N. Y., New York—H. Mandel, 10 East 40th St., is having sketches made for the construction of a 46 story office building at Park Ave. and 40th St. Estimated cost $5,000,000. Farrar & Watmough, 10 East 40th St., are architects.

N. Y., New York—New York Central R.R., 466 Lexington Ave., is having tentative plans made for the construction of a freight terminal and warehouse at Spring, Washington and Clarkson Sts. Estimated cost $15,000,000. B. F. Freeman is chief engineer.

N. Y., New York—Tompkins Sq. Holding Corp., H. Siefke, Pres., 2 West 45th St., plans alterations to boiler room, etc. Estimated cost $40,000. F. Straub, 147 4th Ave., is architect.

N. D., Grafton—Bd. of Administration, E. G. Wanner, Secy., Bismarck, plans the construction of a heating plant at State School for Feeble Minded here. Estimated cost $150,000. Engineer not announced.

O., Cincinnati — Cincinnati Union Terminal Co., Temple Bar Bldg., will soon award contract for the construction of a 1 to 6 story passenger station, west of Lincoln Park. Estimated cost $5,000,000. Fellheimer & Wagner, 155 East 42nd St., New York, N. Y., are architects.

Pa., Pittsburgh—S. Gelman, Grant Bldg., is having plans prepared for the construction of a 10 story apartment building at Beacon and Murdock Sts. Estimated cost $1,800,000. Rubin & VeShancey, Union Trust Bldg., are architects.

Pa., Pittsburgh—South Side Hospital, J. E. Roth, Pres., 1800 Carson St., plans addition to hospital including power house, etc., at South 20th and Jane Sts. Estimated cost $1,500,000. P. C. Dowler, Century Bldg., is architect. S. S. Goldwater, 1212 5th Ave., New York, N. Y., is consulting architect.

Tex., Galveston—Gulf, Colorado & Santa Fe Ry. Co., awarded contract for the construction of 8 and 11 story additions to office building including 29 x 52 ft. boiler house, etc. to R. E. McKee, 1918 Texas St., El Paso. Estimated cost $1,000,000.

Utah, Salt Lake City—Union Pacific R.R., 15th and Dodge Sts., Omaha, Neb., is having preliminary plans prepared for the construction of a power plant and steam generating equipment here. Estimated cost $238,000. G. J. Adamson, Omaha, is chief engineer.

B. C., Victoria—Standard Steam Laundry, H. R. Savage, Mgr., 841 View St., plans the installation of a new power plant in laundry establishment. Boiler equipment contract let to Vulcan Engineering Works Ltd., Vancouver.

Ont., Toronto—Canadian National Exhibition, Lumsden Bldg., will soon award contract for the construction of a horse stable building in Exhibition Park including steam heating and ventilation systems, etc. Estimated cost $1,000,000. J. J. Woolnaugh, City Hall, is architect.

Panama—Purchasing Officer, Canal Zone, will call for bids about July 1 for the construction of Madden dam and auxiliary work on the Chagres River to include gravity dam, 1200 ft. long and 220 ft. high; hydro-electric power plant etc.

Equipment Wanted

Boiler and Blower, Etc.—Columbia City, Ind.—Bd. of Public Works, will receive bids until April 6 for heating equipment including water tube boiler, 150 to 175 lb. pressure, also soot blower, etc.

Generators—Yuma, Colo.—City W. H. Jackson, Mayor, will receive bids until April 20 for one or two steam driven generators with accessories and auxiliaries, one or two 200 to 400 kw. Diesel engine driven generators with accessories and auxiliaries.

Ice Making Machine—Brookville, Ont.—Morrison Ice Co., D. Morrison, 342 King St. W., plans to purchase an ice making machine, 10 ton capacity.

Power Equipment—New York, N. Y.—Bd. of Transportation, J. H. Delaney, Chn., will receive bids until April 21 for furnishing and installing power equipment for portions of Lines A and B., Routes, 101 and 109 of independent system of city-owned rapid transit railroads in boroughs of Manhattan and Brooklyn.

Pump—Laguna Beach, Calif.—Laguna Beach County Water District, will receive bids until April 7 for 600 g.p.m. centrifugal pump operating against a head of 340 ft. for proposed waterworks.

Regulators, Etc.—Wellington, N. Z.—Dept. of Public Works, Supplies & Tenders Committee, will receive bids until June 2 for induction voltage regulators; also until May 19 for 2,250 suspension insulators strings complete with fittings.

Industrial Projects

N. J., Jersey City—Montgomery Cylinder & Grinding Co., 678 Montgomery St., plans the construction of an auto engine remodeling plant at Tonnelle Ave. and Allen St. Estimated cost $40,000. Architect not selected.

N. J., Montclair—G. H. Nash, 44 Walnut Crescent, awarded contract for the construction of a 1 story, 85 x 125 ft. factory at 103-07 Grove St. to S. E. Van Zandt, 86 Gordonhurst Ave. Upper Montclair. Estimated cost $40,000.

N. J., Newark—W. Snyder, 790 Broad St., Archt., is receiving bids for the construction of a 3 story, 50 x 100 ft. woodworking plant on New York Ave. for J. C. Kohaut, Inc., 117 Green St. Estimated cost $40,000.

Pa., Bradford—Coca Cola Bottling Works, 20 Roberts St., is having revised plans prepared for the construction of a 1 and 2 story bottling plant. Estimated cost $40,000. Private plans.

Pa., Pittsburgh—D. J. Rex Box Co., Boyd and Locust Sts., is having plans prepared for the construction of a paper box factory. Estimated cost $40,000. Private plans.

Tex., Beaumont—City c/o P. Millard, Secy., will receive bids about May 5 for the construction of a loading and unloading wharf, 36 x 110 ft. Estimated cost $200,000. R. C. Black, City Hall, is engineer. Machinery and equipment will be required.

Tex., Henderson—East Texas Refining Co., c/o F. W. Buford, Tulsa, Okla., will build a 5,000 bbl. gasoline plant near here. Estimated cost $150,000. Work will be done by day labor. Most of equipment purchased.

Tex., Temple—Day-Nite Sign Service, Inc., 824 North Second St., plans the construction of a 60 x 120 ft. plant for the manufacture of safety and commercial signs, 150 daily capacity. Estimated cost $60,000. Equipment will be required.

Tex., Tyler—Taylor Refinery Co., c/o G. L. Ramsey, plans the construction of a 15,000 bbl. refinery. Contract let for two 20,000 and six 10,000 bbl. storage tanks, bubble towers, plate work and condenser boxes to Wyatt Metal & Boiler Works, West Dallas St., Dallas. $60,000. Total cost $350,000.

B. C., Vancouver—Western Bridge Co., Ltd., First Ave. and Columbia St., is having plans prepared for reconstruction of existing structural steel and bridge fabricating plant. Estimated cost $500,000. Private plans.

N. S., Halifax—Neon Tube Gas & Electric Sign Co. Ltd., plans the construction of a plant for the manufacture of illuminated signs. Estimated cost $50,000 to $75,000.